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Contents.

	PAGE
Forthcoming Events	245
An Insidious Form of Competition	245
B.E.S.A.	245
White Metals Institute	246
Book Review	246
Correspondence	246
Random Shots	246
Some Notes on Continuous Casting	247
The Copper Outlook	248
Problems Met in Pattern-Plate Moulding	248
Annual Meeting of the Foundry Trades' Equipment and Supplies Association	249
Contracts Open	249
The Iron and Steel Industry Since the War	250
Solving Industrial Problems	252
Surface Combustion	252
Professor J. O. Arnold (Death of)	252
Unsoundness in Bronze Castings	253
Reports and Dividends	256
Rumbling *versus* Sand Blasting	257
Visit to the Argus Foundry	258
British Engineering Standards Association	258
Catalogues Received	258
Trade Talk	260
Obituary	260
New Companies	260
Personal	260
Company Meetings	260
Iron and Steel Markets	262

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

APRIL 10.

Institution of Welding Engineers:—Ordinary meeting. "Some Interesting Arc-Welded Jobs," Paper by H. B. White and R. Tuddenham.

Institute of Metals (London Local Section):—Annual general meeting. Open discussion.

APRIL 11.

Institute of Metals (Sheffield Local Section):—Annual general meeting. "Refractories and their Uses," Paper by F. Russell.

Institute of British Foundrymen.

APRIL 4.

London Branch (Junior Section):—Ordinary meeting at 49, Wellington Street, London, W. "Foundry Sands," Paper by J. L. Francis.

APRIL 12.

Swansea Technical College Metallurgical Society:—Annual meeting at Swansea.

An Insidious Form of Competition.

At one of the gatherings in connection with the British Industries Fair, the chairman, himself a founder, confessed that he had always regarded founding as a sheltered industry. He added jocularly that there was, after all, no foreign competition in sash-weights! It is, of course, perfectly true that little, if any, competition exists where common castings of this kind are concerned; nor is there much likelihood of such competition coming into existence in the future. On the other hand, there are certain forms of competition in some products of the trade, such as baths and other light castings, that are only too obvious to all concerned, and that require no fresh emphasis. But there is another and less obvious form of foreign competition to which the foundry trade is subject, namely, competition from the castings included in imported machinery.

We would not suggest for one moment that there is any objection to imported machinery. We have every sympathy with the appeal to "buy British," but, like all business men, we recognise that there are times when we must do otherwise. A certain degree of specialisation in manufacture is both desirable and inevitable under modern conditions, and from this it results that different countries produce the best machinery for different purposes. There is undoubtedly an ultimate industrial advantage that will accrue to the manufacturer who purchases the very best equipment made, irrespective of its origin; there is undoubtedly, too, a reciprocity in these matters, the foreign manufacturer being more willing to buy of our best if we buy of his best. But it is no insult to human nature to point out that most of us are ready enough to support a principle when it touches our pocket, and in this matter of the purchase of foreign machinery it is necessary to look a little deeper before reaching a decision.

For the imported machine consists, for the greater part of its bulk, of iron castings. We have been quite unable to determine how these castings figure in the statistical returns; one may presume that they are included under the heading of imported machinery. They are chiefly high-grade castings, emanating from a well-paid section of the trade and commanding good selling prices. If the equivalent British machine were bought, roughly equivalent castings would be required, again emanating from a well-paid section of the trade and commanding good selling prices, but in this case on our own side of the Channel. In other words, every time we buy from abroad a machine that consists chiefly of high-grade castings, we are giving to the foreign ironfounder the very work which we ourselves are so anxious to obtain.

We repeat that, in spite of all these considerations, it may still be desirable to purchase foreign machinery. It should not, however, be done blindly or without due consideration of the fact that imported foreign machinery provides a most insidious and dangerous form of competition in the foundry trade.

B.E.S.A.

The work of the British Engineering Standards Association is widely known and appreciated by founders, and it is desirable that they should be kept informed of interesting developments in connection with it. The Balfour Committee on Trade, whose report we dealt with in these columns at some length, made certain recommendations concerning the B.E.S.A., involving its more complete and more official recognition by the Government, and involving also the payment of an increased sum from the Treasury. It is now understood that the Government is to provide a block grant of several thousand pounds a year, some part of this sum being contingent upon the attainment of a specified figure by subscriptions from industrial sources. Like other organisations that depend in whole or in part on the voluntary support of industry, the expenditure of the B.E.S.A. is practically fixed from year to year, although with an upward tendency due to the inevitable and desirable extension of its activities, while its present methods of raising income make it subject to fluctuations which really prevent the Association from knowing precisely where it stands.

There can be no doubt whatever as to the advantages and economies of standardisation, and it is only the very shortsighted industrial outlook that objects to it as against the interest of particular firms. Those who are the keenest supporters of industrial standardisation believe in simplifying production at home in order that we may the more readily meet competition abroad. Nor is there room for anything but satisfaction with the work of the B.E.S.A. itself. It has recently completely reorganised its Council and methods of control, and each industry now has a separate committee, the subcommittees dealing with individual specifications being attached to these. We understand that strong representations have been made that the iron and steel industry should have its own committee, its omission from the list of committees as originally announced being, indeed, quite inexplicable. There is, however, no change in the basic policy that the drive towards standardisation must come from the industry concerned, the committee set up to deal with a request being

composed equally of producers and consumers who are presumed to have a common interest in this particular case of standardisation. A very significant feature of the B.E.S.A.'s work consists of its relations with standardising bodies throughout the Empire—Australia, New Zealand, India, Canada and South Africa. In addition specifications have been translated into foreign languages for use abroad. Altogether the work of the Association has an extremely important bearing on the dissemination throughout the world of Anglo-Saxon business principles and methods of testing and measurement.

If a broad view be taken of the need of standardisation and simplification for British industry as a whole, the B.E.S.A.'s only serious failing is that it does not go fast enough or far enough. The field is enormously wide, and the nature of its organisation limits both its scope and its speed. Moreover, and this is the point of real significance—it depends entirely upon industry for the stimulus towards standardisation in any given direction. The organisation is there, an organisation of proved value and efficiency, and one having real prestige and authority. But the initiative lies with industry, and it is for industry to appreciate the full significance of this fact.

White Metals Institute.

The Institute of White Metals, which was formed at New York last month by leading smelters and refiners and manufacturers of white metals, with temporary officers, held a meeting at the Pennsylvania Hotel on March 18 to elect permanent officers and a board of directors. The temporary officers of the institute have found a definite and growing sentiment in the various branches of the trade that the work planned by the institute should be started as soon as possible.

A meeting held in Chicago on March 7 indicated that leading white metal manufacturers in that territory subscribed to this opinion. At this meeting it was tentatively decided to restrict, for the time being, membership to three groups: Smelters and manufacturers of antimonial lead, manufacturers of solder, and manufacturers of Babbitt and type metals.

Book Review.

The Creep of Steel at High Temperatures.—By F. H. Norton. Published by McGraw-Hill Publishing Company, Limited, 6, Bouverie Street, London, E.C.4. 1929; cloth; pp. vii + 90. Price 15s. net.

The author tells in his preface that this investigation was carried out in the Massachusetts Institute of Technology for the Babcock & Wilcox Company because of the discrepancies found by previous observers and the need for further development of the necessary apparatus. His effort in the present book is to supply the engineering data for a large number of materials upon which still more fundamental research may be based. The necessity for more knowledge concerning the behaviour of steels when exposed to high temperatures for a long time has arisen within a relatively few years owing to the increased use of such plants as superheaters, oil stills, mercury boilers, etc. There is still little information about the flow of hot steel; the apparatus used was designed to give a prolonged heat to six specimens at a time over a good length in an atmosphere of nitrogen, to prevent oxidation. There are numerous photographs of the machine, graphs, tables and microphotographs of many steels before and after treatment. The creep values may be applied to design by selection corresponding to the desired life and extension. It was found that high-chromium, high-nickel austentitic steel seems to offer most resistance to creep and to heat, and has most permanency of structure. High-chromium stainless steels are inferior in these respects. From the British point of view, it is rather annoying to find heat values in degrees Fah. rather than Centigrade.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Middlesbrough Convention.

To the Editor of The Foundry Trade Journal.

Sir,—I shall be obliged if you will permit me to remind the members of the Institute of British Foundrymen of the Twenty-seventh Annual Convention, which will be held at Middlesbrough.

The Convention will open on Tuesday, June 17, and will continue until the following Friday, June 20. The arrangements are already in an advanced state, and the President-elect, Mr. F. P. Wilson, in conjunction with a strong local Committee, has arranged a programme which will commend itself to all members who are fortunate enough to be able to be present.

The Papers to be presented are of a type which will appeal to the practical foundryman, and include a number of short Papers on steel foundry practice and several Papers dealing with practical moulding procedure.

Visits will be paid to most of the principal iron and steel works of Middlesbrough and district, and the social aspect of the Conference is also being adequately catered for. Ladies will find that ample provision is being made for their entertainment and enjoyment, and, although Middlesbrough is an industrial town, there are several very attractive seaside resorts within easy reach, and the scenery of the Cleveland hills in the immediate vicinity of the town has a charm of its own which should appeal to the delegates and ladies.

May I also point out that a Pan-European Congress is being organised by the Belgian Foundrymen's Association at Liége, and will be held during the last week in June? This Congress is being held as part of the International Congress of Mining, Metallurgy and Applied Geology, which, in turn, is being organised in conjunction with the International Exhibition to be held at Liége this summer. Arrangements are being made for members of the Institute of British Foundrymen and their ladies to visit this Congress.

Detailed particulars of both these Congresses will be forwarded to all members of the Institute in due course, but in order that members may plan out their arrangements for the coming summer, I shall be glad if you will allow me to announce these preliminary notices through your columns.—Yours, etc.,

Tom Makemson,
General Secretary,
Institute of British Foundrymen.
St. John Street Chambers,
Deansgate, Manchester,
March 31, 1930.

Aluminium in Crane Construction.—According to Messrs. F. V. Hartmann and E. C. Hartmann, in the "Iron Trade Review," a new application of alloys of aluminium in the field of structural engineering is found in the 10-ton travelling crane recently installed in the works of the United States Aluminium Company, Massena, N.Y. While there are numerous examples of aluminium structures, such as motor truck bodies, large shipping and storage containers, railway cars, etc., this is the largest structural application to-day, with the exception of the frame-work for lighter-than-air craft. Briefly described, the crane is a 3-motor, single-hook machine with a lift of 22 ft. The bridge is made from two double-web girders spaced 7 ft. on centres. The girders are constructed of aluminium alloys, and have a span of 72 ft. 2 in. Aluminium was also used in the walkway, handrails and operator's cage. The bridge girders frame into cast-steel carriages at their ends, and a one-piece cast-steel trolley carrying the hoisting mechanism is mounted on the girder rails. The design of the crane was based largely upon the usual practice followed in building steel cranes, although certain departures were necessary in the case of the bridge girders since aluminium and steel differ in some of their mechanical properties.

Random Shots.

It is not my job to be political; but there seems to be little to choose between one Party and another when it comes to taxation, and at this time of year a little grousing on the subject is appropriate enough. Comically enough—and it is oddly comforting, as a matter of fact—it is not only the taxpayers who are grumbling this year. Formidable figures of the deficit in income tax, super-tax and death duties have been published, and the Chancellor of the Exchequer is said to have lamented that rich people are disobligingly living longer than was their wont. One is forced to the conclusion that there is something gravely wrong when a great statesman alters his will just before his death in order to reduce the amount payable in death duties. Plenty of perfectly honest people will gaily defraud a railway company or a government department in some matter of sixpences or shillings; the morality of evading death duties is a more formidable problem.

* * *

All this is really by way of preamble to the report on "The Effect of Taxes upon Prices," issued by the General Federation of Trade Unions. Something of a sensation was created by remarks of this kind over the signature of well-known trade unionists: "It is foolish to expect that the social improvements for many millions can continuously be paid for by exactions from the wealth of a few thousands." A good deal of credit is due to the courage of those who are prepared so frankly to criticise the policy of the Party to which they are presumably bound.

* * *

The facts in themselves are nothing new. It does not take an economist to realise that the wealth of the nation consists of the products of its industry, including agriculture, and that no real advance can be made unless there is an increase in those products. Add a shilling to the super-tax in order to increase unemployment benefit, and what do you do? You take away from one man the capacity to buy a third car or a Bond Street gown for his wife, and you give to many other men the capacity to buy a few more vegetables or another pair of boots apiece. That is to say, you reduce employment and possibly wages in the motor trade or the dressmaking business in order to increase employment and possibly wages in market-gardening or boot manufacture. (But to a less extent, because they are less skilled and specialised trades, and because there is a not inconsiderable "loss in transit"—expenses of collection, etc.) And when you reflect that the first man quite often decides in favour of industrial investments instead of the third car, while the other men practically never decide in favour of national savings certificates instead of cabbages or boots, the need for clear thinking on the subject becomes abundantly plain.

* * *

Glancing the other day at a picture paper, I saw a photograph of a golfer—I think in a 'varsity match—in difficulties with a flooded bunker. He looked as if he could do with a shrimping net rather than a club, and I was reminded of the story of the novice who went round using every club in turn, always hopeful and always disappointed. He succeeded ultimately in landing his ball neatly in a rabbit-hole. "What club will ye be wantin' now, Sir?" asked the caddie. The novice considered. "Have you," he said at length, "have you one shaped something like a ferret?"

Marksman.

Some Notes on Continuous Casting.

By "Ecossais."

Judging from recent reports and discussions it would appear that a number of foundrymen have rather vague ideas of the reasons for installing a system of continuous casting.

The impression that continuous casting is only a recent development is not correct, as, to the writer's personal knowledge, such methods have been in use in at least two foundries for over thirty years, and had probably been in use a considerable time previously. As no system of continuous casting can be considered complete without sand-preparing and conveying plant, conveyors for delivering castings to the dressing shop, and conveyors for returning scrap and runners to the place where the cupola charges are made up, recent developments have been along these lines, full advantage being taken of the use of the moulding machines and, wherever possible, mechanical charging of the cupola.

The conditions creating the need for and the advantages of such a system may be, among others:—(1) The necessity for increasing output from an already crowded floor-space; (2) reduction in amount of wasted labour by manhandling of the boxes, sand, gates, castings and other materials; (3) better control and thus avoidance of waste of new sand, coal dust, and scrap metal; (4) reduction in the number of patterns, thus giving greater regularity of product, especially if the castings are required to fit into jigs for machining; and (5) reduction of boxes required.

Economy in Red Sand and Coal Dust.

Extravagant claims for economy of new sand and coal dust are often made, but it will be found that any economy in this direction is limited to that obtained by centralisation of the mixing plant and better control of the additions. One French firm of foundry engineers control the proportions of old sand, new sand, and coal dust automatically. Just because many foundries use a standard mixture of, say, 2 parts black to 1 part new sand, with a certain amount of coal dust, it does not follow that 5 per cent., say, of new sand would be economical if the whole of the floor sand had to receive such an addition.

It may be found in practice that even 2 per cent. is sufficient, and generally it may be taken that, except for the saving due to centralisation of the mixing plant, so far as light castings are concerned, the same amount of new sand can be used whether continuous or non-continuous casting is the method used. The correct amount of new sand to add is the amount actually burnt by contact with the metal, and if this were added to the sand on the non-continuous floor and the whole of the sand manipulated, the same results would, of course, be obtained. This is not always practicable, especially if milling is required, hence the practice of using "facing sand," which it is not practicable to apply in as thin a layer as the thickness of metal requires, except perhaps on flat castings, some also being continually spilled on the floor. This "facing sand" also contains good proportions of new sand and coal dust, and the excess thickness of the layer usually enriches the floor sand to such an extent that at intervals it would be possible to dispense with "facing sand" for the day without any great difference in the appearance of the castings. The result of the gradual increasing of the new sand and coal dust due to the enrichment of the floor sand by the outer portion of the "facing sand" not actually burnt is seen in the very shiny appearance of the castings and a rapid increase in the number of "cold short" castings, especially showing up on matted surfaces. If one draws a finger over the shiny faced castings it brings away with it a shiny substance resembling plumbago, although probably no blacking of any kind is ever used on the moulds. To remedy this the proportion of coal dust is considerably reduced until the castings show a deficiency and the same thing happens again. There certainly appears to be a need of some rapid method for indicating the amount of coal dust left in floor sand to avoid such waste and variation in the appearance of the castings when facing sand is used, and it is in this respect that, with continuous castings and sand handling plant using no facing sand, economy is obtained.

Moisture Content.

The importance of a regular and approximately correct amount of moisture is equal to that of the amount of new sand and coal dust, and excess will increase the tendency for the prepared sand to stick in the bins supplying the moulding machines from overhead; the castings will come out rough on the vertical faces due to reduced flowing properties, liability to hardness will be increased, especially in places away from the runner, where the metal does not circulate prior to setting. If the sand is fairly dry, clagging to the pattern and rough castings are easier to avoid, but the moulds are more easily damaged, so that smooth, well finished patterns are more necessary than with the damper sand. Automatic control of the moisture contents of the sand is rather difficult, or at least not practicable, and depends on the sand machine attendant, who may, however, get fairly efficient, and so long as the same new sand is used will obtain quite satisfactory results, except for odd occasions when he accidentally adds too much water. The water should be added by a fine spray to spread the time over a longer period and create less liability to excessive additions of water, the sand also absorbing the water more readily as a spray. Of course, the ideal method of getting the correct amount of moisture would appear to be to dry all sand and add a measured amount of water. The expense of drying, then cooling, and extra time for mixing such dry materials would make the method too expensive to operate. It may also be necessary to provide extra storage for prepared sand to allow it to stand and improve, a great probability if a start was made with all materials dry and particularly with fine sands. Any advantages gained would thus be outweighed by the disadvantages, and such method could not be considered practicable.

Dry-Sand Working and Jobbing.

Although it would not be practicable to use a continuous casting system for the above, advantage could be taken in a large foundry of the conveyor system for transporting moulds first to a casting floor and then to a knock out floor, so that moulding and assembling could proceed continuously in one part of the foundry without the intermittent waste of time caused by emptying, mixing, and removing castings on the actual moulding floor. From the knock out the backing sand could be returned after being treated in a mixer to several bins over different parts of the moulding floor. The facing sand also could be stored in one or more bins, but not over the actual moulding floors.

In the case of dry sand moulds, these would be removed to the stove and, after drying, assembled and put on the casting floor along with the green sand moulds. It may happen that numbers of the green sand jobs have previously been made in the floor, so that more moulding boxes will be required, and possibly this may be advantageous in many ways.

Metal for Continuous System.

Unless the same quality of metal will be suitable for all castings made on the system, it may be advisable to run one quality of metal in the forenoon and another quality in the afternoon. The alternative to this would be to have separate continuous units, each using its own particular grade of metal and having its own cupola or cupolas. The custom of using one cupola for one grade of metal only has been practised for many years by firms making repetition castings and having as many as a dozen cupolas or more. Besides ensuring a constant supply of metal, it is necessary to ensure that enough moulds are prepared to take this and avoid frequent cupola stoppages. An advantage in favour of several small units as against one large unit would be that in the case of a breakdown only the unit concerned would be stopped, and this would thus not be so serious a matter as if the large unit was stopped.

Although, due to the variety of designs of essentially the cast casting (or at least to serve the same purpose) in this country, continuous casting is not as easy a proposition here as in the United States, there are numbers of opportunities already existing, and it should not be difficult to increase these.

As an example of such an opportunity, one might consider the ordinary gully grid, of which there are numerous designs created by foundries and architects. It should be quite as easy to standardise these and still meet the requirements of local authorities, as is the case with, say, the Whitworth bolt or standard elbow pipes. The same remarks could be applied to electrical resistance grid castings, and then if an engineer or architect wanted some special design he would know that he must expect to pay for it. Numerous other examples will also occur to foundries in the different branches of the engineering trade.

Apart from this, there are many foundries engaged on repetition work who could, with advantage and relatively small extra expense, adopt continuous casting. The castings on any unit need not necessarily be alike, and as for the metal many works keep certain of their foundries to one particular grade continuously, so that all they require is the conveyor system to supply sand and take away moulds and to arrange the moulding machines accordingly.

The individual weight of the castings made on any one unit may, subject to the metal being suitable, vary from, say, half a pound to one cwt. A unit thus engaged could not, of course, be run as smoothly as one using a standard box containing one or more castings. Work should be so arranged that necessary changing over of patterns is done during meal hours to avoid disorganisation.

Specifications.

Where castings are required to specifications, the use of a continuous system should help to reduce difficulties rather than increase them. As regards dimensions, the product should be more regular, as, in order to ensure that enough moulds are forthcoming, difficulties due to bad patterns could not be allowed to exist. Twisted joints on castings could be better avoided, as there would be fewer moulding boxes to keep in order. The necessity for having a continual supply of molten iron would rather help to create regularity in same. Differences due to variations in the cooling times would not be so apparent, as the period between casting station and knock out station would be fairly uniform. The necessities of a successful sand preparing and conveying plant make for a regular appearance of product.

Question of Labour.

The writer has in mind certain castings which under older conditions required a type of labour not easily obtained, and which by a number of foundrymen would not be described as skilled labour. The necessity for increased output caused methods to be adopted which removed the difficulty of labour, and at the same time improved the general quality of the castings. On a continuous plant there will be men operating

the machines, coring and closing moulds, fixing clamps, casting, removing clamps, emptying boxes, despatching castings to the sand blast machine, sand blasting, grinding, inspecting and despatching same to machine shop. So far as the foundry, there is no reason why the men engaged on the plant up to and including removal of the castings should not become interchangeable, an arrangement that could not readily be made with the ordinary and older methods of production, and brought about by good patterns, efficient moulding machines, good boxes, and efficient clamping and casting methods.

Core-making methods would have to be brought in line to meet increased demands, employing machines and even continuous core drying stoves if necessary. With such a system it should be possible to increase the average remuneration of the men employed, and the difference in rates need not be so large as at present obtains in most repetition foundries.

The Copper Outlook.

"To the extent that this is an electric age, it is a copper era," states Dr. Donald Marvin, economist of the Royal Bank of Canada, in the Bank's March Bulletin in a review of world copper production and Canada's growing part therein.

By the end of 1930 Canada should be producing at the rate of 160,000 tons a year. This is rapid progress, for last year production at 121,000 tons showed an increase of 20 per cent. in quantity and of 80 per cent. in value. The rapid exploitation of new fields in Ontario and Quebec is an outstanding feature. Nevertheless, as Canadian output represents only 5 per cent. of world production, the price received by Canadian producers will continue to be governed by world conditions of supply and demand.

Commenting on the low operating costs of the larger mines of the Western Hemisphere—under 9 cents a lb.—the Bulletin states that there seems thus to be no great probability that the new large-scale methods of production will bring a glut of low-priced copper, since volume of production has been regulated by consumption rather than by price. Operating costs at Noranda, the largest of the new Quebec properties, are as low as 4.84 cents per lb., after crediting other metals. This record is beaten by only one other mine, namely, Cerro de Pasco, at 2.40 cents. The world consumption of copper in 1929 is estimated at two million tons.

In the United States, which, in conjunction with the Copper Export Association, owns and controls three-quarters of the world's output, consumption is increasing and less than two months' requirements were on hand at the end of the year. *Per capita* consumption, at 17 lbs., has, in fact, doubled in eight years.

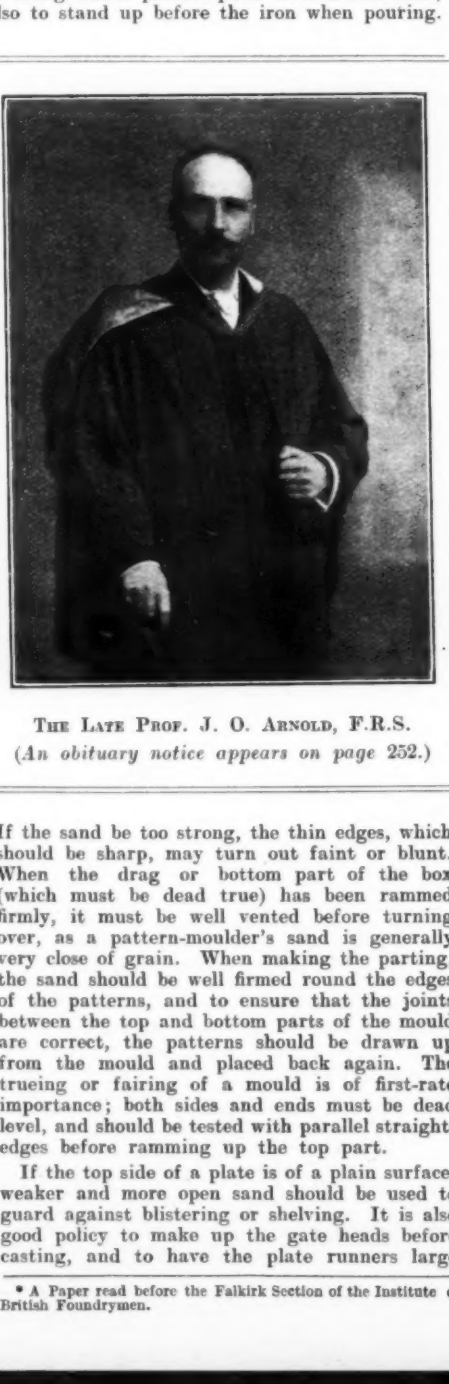
Chromium-Plated Gauges.—Important savings in time and costs have been effected in the use of gauges, tools and other equipment by the Ford Motor Company, Detroit, as the result of the successful application of hard chrome plating to these gauges and machine parts. A recent issue of "Ford News" points out that for many years it was known that chromium plating added greatly to the length of life of gauges, tools, etc. The problem was to find the right kind of steel to use, as well as the right method of manufacture, so that the hard chrome plate would stay on, and not be peeling or chipping off. Having solved the problem, plated gauges now are giving 218 hours in certain grinding operations, where formerly four was the limit. Costs have been reduced more than one-half. The amount of scrap or rejected parts in production has decreased because the gauges retain their close limits longer.

Problems Met in Pattern-Plate Moulding.*

By A. Irvine.

There are some difficulties to be guarded against in the making of a pattern-plate, such as bending, twisting, springing and drawing or sinking. Before starting to make a pattern-plate, the original pattern should be examined very carefully and placed inside the plate frame in a way so as to have the plate balanced, and thereby ensure sweet working of both sides of the plate, and always keeping in mind to leave space necessary for the proper running of the castings.

The patterns should be bedded level on a hard-rammed and level top part, but some patterns may be slightly tilted to ensure better working of the plate, unless, of course, the patterns have been set properly on a board or block. The facing sand should be strong enough to bring out a pattern-plate with a fine skin; also to stand up before the iron when pouring.



The Late Prof. J. O. Arnold, F.R.S.
(*An obituary notice appears on page* 252.)

If the sand be too strong, the thin edges, which should be sharp, may turn out faint or blunt. When the drag or bottom part of the box (which must be dead true) has been rammed firmly, it must be well vented before turning over, as a pattern-moulder's sand is generally very close of grain. When making the parting, the sand should be well firmed round the edges of the patterns, and to ensure that the joints between the top and bottom parts of the mould are correct, the patterns should be drawn up from the mould and placed back again. The trueing or fairing of a mould is of first-rate importance; both sides and ends must be dead level, and should be tested with parallel straight-edges before ramming up the top part.

If the top side of a plate is of a plain surface, weaker and more open sand should be used to guard against blistering or shelving. It is also good policy to make up the gate heads before casting, and to have the plate runners large enough so that the mould can be filled up quickly. When finishing a plate mould, heavy parts, such as screw-bats and core-prints, should have a wrought-iron nail or wire put into that particular part of the mould to keep those parts from drawing or sinking, and, where there are any empty spaces on a plate mould, strengthening bars should be cut out of the mould, thereby adding strength to and keeping a uniform heat on the plate after casting. Some pattern-plates are taken from the mould quite straight, but the majority take bend either one way or another. Of course, it depends greatly on what is on the plate and how it is placed.

If a pattern-moulder gets some patterns handed to him to be put on a plate a certain way, he is expected to turn out a straight plate whether the plate is properly balanced or not, which is not always achieved in practice. If a plate has three heavy or bound corners and one light or open corner, the light corner has every tendency to move one way or the other, although the mould has been made dead true. Sometimes a plate will have a heavy piece at one end and a light piece at the other end, which must affect the bend. Again, there are plates with only one piece on them covering the whole of the plate; some of these may come out straight, but most of them take bend less or more, depending chiefly on whether the original pattern was straight or had a bend on it initially.

To prevent a pattern-plate from bending, a pattern-moulder must use his own judgment, and, if necessary, turn his mould (after casting) on edge, and strip off the sand where it is likely to bend for the purpose of trying to hold it straight, but the difficulty is to know exactly when to start stripping, because to strip too early means pulling it and causing a bend. When a plate is almost square, it very often takes bend on the ends as well as the sides, but to put sweep or bend on a mould to counteract a bend is bad practice, because, if a plate is allowed to take bend, it takes what is on the plate along with it, and the result would be bent castings.

Another difficulty which is often encountered is the springing or cracking of pattern-plates, especially at the corners where there are pockets. It is often found necessary to raise and sometimes to lower patterns from the joint of the plate box to suit plant belonging to some other job, that forms a shoulder right round the plate and causes the corners to spring or crack, also altering the bend considerably. There is a great strain on a plate of that kind, and generally they do not last long in use. Alterations made on a plate mould, such as putting on and filling up strips, making and filling up openings, weakening one part and adding strength to another part, all go to increase the difficulties in bringing out a straight plate pattern. Alterations in a mould with cobbled patterns may save pattern-making at the time, but it generally reacts on the castings when finally fitting up, not only so, but when the same plate has to be renewed, the same performance has to be repeated.

To give a pattern-moulder a chance to make a good plate, the original patterns ought to be perfect, and rather than alter a pattern to make it suit something else, it is good practice, and cheaper in the end, to make up a proper pattern. Original patterns cobbled with wood, tin, stucco and paper seldom, if ever, give good results when put on a plate, and it is very difficult for a pattern-moulder to tell how a plate will turn out under these conditions, although he may have an idea if he has previously made one similar. Before castings are taken off a new plate, they should be properly tested by the pattern-moulder and the castings weighed against the original patterns (provided they are all iron), and, if the weights do not correspond, that can be remedied by adjusting the fitting strips on the corners of the plate.

* A Paper read before the Falkirk Section of the Institute of British Foundrymen.

Annual Meeting of the Foundry Trades' Equipment & Supplies Association.

MR. A. S. BEECH ELECTED PRESIDENT.

The annual meeting of the above Association was held last Thursday at the Holborn Restaurant. It was preceded by a luncheon, over which Mr. Harry Winterton presided. The toast of "The Association" was given by Mr. John Cameron, J.P., a Past-President of the Institute of British Foundrymen, who referred with pleasure to the fact that it was during his year of office that the representatives of the foundry equipment industry were admitted as members of the Institute. Mr. Winterton, in reply, stressed the fact that there was a real mutuality of interests which could best be served by the common study of each other's problems. In vacating the chair, he paid a warm tribute to the help he had received from his colleagues on the Council, and, especially Mr. K. W. Bridges, the honorary secretary.

A vote was then taken as to the most suitable year for holding an Exhibition, and it was decided in favour of 1933.

The balance-sheet and report were then submitted and passed.

Annual Report, Year ending December 31, 1929.

In submitting for the consideration of members the duly audited accounts of the Association for the year ending December 31, 1929, the Council feel that general satisfaction will be evinced that the Association steadily maintains, and even strengthens, its financial position. The expenses are kept so exceedingly low that even with a very limited income it is still found possible to show a small profit for the year's work. It is particularly gratifying that on this occasion it was found possible to distribute practically the whole of the revenue accruing to the Association from the Exhibition as rebate amongst participating members, and only a very few pounds were retained towards providing for working expenses.

During the year it was found necessary to write off the names of two members whose internal arrangements did not permit them to continue membership, and, on the other hand, two new members have been recruited. In addition, one has resigned, so that for the year commencing January 1, 1930, records show a total membership of 37.

The great activity of the Association during the year under review was, of course, the International Foundry Trades Exhibition (including machine tools and woodworking machinery). The success of that undertaking has been acclaimed and attested on all sides, and it is hardly necessary to recapitulate any of the details in this report. It should, perhaps, however, be placed on record that the co-operation which was established for the first time with the Machinery (Machine Tool and Woodworking) Importers' Association of Great Britain, by which a most interesting display of machine tools was made in the Gilbey Hall, was fraught with great advantage to all concerned, and in every respect the Exhibition was certainly the most representative that has ever been held in this industry in this country.

We certainly could not issue this report without making reference once again to the Technical Non-Commercial Exhibit which marked a great advance both in general arrangement and detail on the similar exhibit in 1926. The best thanks of the entire industry are undoubtedly due to the very distinguished Committee which was responsible. The arrangements in connection with the International Congress and the Convention of the Institute of British Foundrymen were carried out most satisfactorily, and we once again take this opportunity of thanking the various officials concerned. In this connection it may be recorded that the departure made in the provision of a Central Hospitality Fund seems to have been eminently successful, and one branch of the Institute very generously did not even feel it necessary to accept their quota.

Close upon the heels of the winding-up of one Exhibition comes the consideration of the next, and this is a matter which is already receiving the closest attention of the Council. There are a number of factors, both national and international, which have to be taken into account, and it is, perhaps, premature to give publicity to these preliminary discussions. It is, however, the general hope that it may be found possible to arrange the next Exhibition at no very distant date, in circumstances which will commend themselves as much as have those in the past to manufacturers and foundrymen alike.

Mr. A. S. Beech

(the recently-elected President of the Association).

About the middle of the year your President accepted, with the grateful support of the Council, an invitation to serve on the Anglo-Russian Committee, under the chairmanship of Sir Joseph Isherwood. He attended some meetings of this Committee, as a result of which he felt that its plans were on too ambitious a financial scale to commend themselves to the support of a body with such slender resources as our own, and in view of that and of the political changes which had taken place in the meantime, he resigned in all capacities from the Anglo-Russian Committee. This policy was subsequently duly noted and endorsed by the Council.

Arising out of some comments which appeared in the Press, comparing British foundry equipment and management in general unfavourably with that in other countries, a small Press Propaganda Committee has been formed which is investigating the best means of giving publicity to the work of this Association and that of its members. Co-operative advertising has been suggested, but the obvious difficulty of cost exists.

One useful service which it is felt members may be able to render one another is by their notifying the office of the fact that they are in possession of useful information regarding the financial standing or trading reputation of potential customers. The details of this scheme have been circulated and it is hoped that it may become of use in the future.

A scheme has also been brought to the attention of members, whereby in certain circumstances preferential rates of membership are in force if members of this Association should wish to join the British Engineers' Association. Members are, therefore, reminded that should they desire to join that body it would be to their advantage and to that of others if they will notify the office of their intentions.

The practice of working out an average business trend curve by information supplied by some of the members is carried on from year to year, but it is noted that only a small proportion of the members care to participate in this scheme, and the number of these remains about the same each year. It is possible that this number would be increased and the information be made proportionately more comprehensive and useful if members fully realised that they are not asked to divulge any figures, but merely percentages of increase and decrease, and that no person whatsoever, other than the honorary secretary, is ever made party to the individual information given.

One other detail is noted with considerable satisfaction. We have received during the course of the year one or two inquiries from Colonial buyers addressed to this office, which, of course, goes to show that the Association is coming to be recognised in far-distant places. These inquiries are appropriately handled immediately they are received.

We would wish to close this report by recording the continued thanks of the Association as due to the official organ, The Foundry Trade Journal. Particularly in the matter of Press propaganda above referred to, it is confidently anticipated that the services of the Journal will be of increased usefulness.

Mr. Beech proposed a vote of thanks to the President, and suggested that a souvenir medal should be offered to the chairman as a memento of his two years' tenure of office. Mr. Lennox seconded, and the motion was carried with enthusiasm.

The three retiring members of Council were re-elected.

At a subsequent meeting of the Council, Mr. A. S. Beech, of the Universal System of Machine Moulding Company, Limited, was unanimously elected President, and Messrs. D. H. Wood, D. W. Lennox, D. Sharpe and Major J. W. Athey were elected Vice-Presidents.

Contracts Open.

Cairo, May 27.—Supplying, laying and jointing 14,530 metres of cast-iron spigot and socket pipes from 3-in. to 20-in. dia., together with specials and valves, for the Ministry of Public Works. The Department of Overseas Trade. (Reference A.X. 9,292.)

Port Elizabeth, S.A., April 24.—Cast-iron pipes, for the City of Port Elizabeth Electricity Department. The Department of Overseas Trade. (Reference A.X. 9,313.)

Preston, April 12.—7,600 yds. of 36-in. dia. and 167 yds. of 33-in. dia. cast-iron pipes, for the Town Council. The Borough Engineer and Surveyor, Town Hall, Preston.

Pewsey, April 10.—Supply and installation of new pumping machinery at the Pewsey waterworks, for the Rural District Council. Mr. W. Slater, clerk, Pewsey, Wilts.

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The Iron and Steel Industry Since the War.

A REVIEW OF THE INDUSTRY IN GREAT BRITAIN AND FOREIGN COUNTRIES.

By M. S. Birkett, O.B.E.

(*Continued from page* 238.)

GERMANY.

The Treaty of Versailles completely altered the basis of the iron and steel industry in Germany. In 1913 the total output of the German Customs Union, including Luxemburg, comprised 19,300,000 tons of pig-iron, and 18,900,000 tons of crude steel. Under the Treaty of Versailles—which separated Luxemburg from the German Customs Union; placed the Saar under French hegemony for a period of fifteen years; and detached Alsace-Lorraine and part of Upper Silesia from Germany—Germany lost some 80 per cent. of her production of iron ore, 42 per cent. of her production of pig-iron, 37 per cent. of her production of crude steel, and 34 per cent. of her production of rolled products.

In addition to the actual physical loss which Germany suffered, another very important result of the Peace Treaty was the dislocation of the commercial connections which had previously existed between the Rhenish-Westphalian metallurgical centres on the one hand, and Lorraine, Luxemburg and the Saar on the other. In pre-war days the iron and steel industry in Rhenish-Westphalia was based on the smelting with local coal of the minette iron ore transported from Lorraine and Luxemburg: the importance of this ore field is clearly seen when it is stated that before the war it produced almost 30 per cent. of the total world output, and more than 75 per cent. of the total domestic output of the pre-war German territory. Whereas in 1913 Germany (including Luxemburg) produced 35,900,000 tons of ore, her output in 1928 was 6,300,000 tons. As a result of the changes effected by the Peace Treaty, therefore, Germany has had to look abroad for her supplies of iron ore.

She has in consequence entered into long-term contracts with Sweden, Spain, Newfoundland and North Africa designed to safeguard her ore supplies for a long period. The most recent development of this policy is to be seen in the contract which has lately been concluded between a German metallurgical group, headed by the Vereinigte Stahlwerke, and the French iron and steel concern, Marine-et-Homécourt, under which Germany is to obtain at a fixed price a supply of 800,000 tons of ore per annum over a period of ten years: this contract is particularly interesting, illustrating as it does the strength of the previous economic links even under altered political conditions.

The economic connections existing between Rhineland-Westphalia on the one hand, and the territories ceded under the Treaty of Versailles on the other, were not confined to the transfer of ore. Scrap, pig-iron and semi-finished material were transported north in addition to ore, and in return coal, coke, machinery, tools, etc., were sent back in exchange: all these connections were severed by the Peace Treaty.

Steel Ingot Syndicate and Union of Steel Works.

The first result of the negotiations which took place was the formation of the Rohstahlgemeinschaft (Steel Ingot Syndicate) in November, 1924. This syndicate is a production organisation and does not undertake the task of allotting orders or sales, or of fixing prices. Each member received a participation "quota" of ingot steel equivalent to twelve times the amount of ingot steel produced in any month during the period January 1922, to October, 1924. The regulations provided that the amount to be produced in any one month was to be decided by the management committee and that, should the member exceed his quota in two consecutive months, reckoned together, he was to be obliged on demand of the management to pay immediately into the account of the management an amount of 25 marks per ton of ingot steel in excess of the allotted quota. Provision is also made for the transfer of quotas so that those members who are not in a position to work at a profit or to cover costs of production are at liberty to dispose of their quotas to those in a more favourable position. In cases where quotas are transferred, either temporarily or permanently, notification of the transfer must be made to the management committee.

The formation of the Rohstahlgemeinschaft was regarded not merely as an endeavour to adjust production of ingot steel so as to bring it into conformity with prevailing market conditions, but also as the first step in the formation of separate syndicates to deal with the various sections of the iron and steel industry. The Stahlwerks Verband (Union of Steel Works) was established in its present form in July, 1925, to control the sales of semi-finished material, sections, permanent-way material, bars, heavy plates, hoops and strips. The Stahlwerks Verband had previously been in existence as a selling syndicate for the so-called "A" products (semis, sections and permanent-way material) from 1904 to 1920, but had then been dissolved. The only syndicate which succeeded in carrying on without interruption during the difficult post-war years was the Roheisenverband (Pig-iron Union), which was formed in 1842 and which controls the prices and selling conditions of the total pig-iron produced for sale by its members.

German Domestic Market.

It will thus be seen that rapid progress was made by the German steel manufacturers in their efforts to secure control of the domestic market, in which they were aided by the high protective duties in Germany, which secured the home market for the German producer. The German domestic market is normally responsible for the consumption of upwards of 70 per cent. of the total output of the industry. At the time when the import duties were re-introduced in 1925, the steel-consuming industries in Germany became apprehensive regarding the reactions on their trade of a highly-protected home market for primary iron and steel goods. After considerable discussion between the producing and consuming interests, the consumers agreed not to oppose the duties, and in return the steel producers undertook (i) to safeguard the interests of the finishing industries in the Commercial Treaty negotiations which were then proceeding with France, and (ii) to grant to the steel-consuming industries price rebates on primary iron and steel goods which were destined to be worked up and exported.

This arrangement was embodied in an agreement (known as the AVI agreement) which was concluded in July, 1925, between representatives of the Rohstahlgemeinschaft and the Arbeitsgemeinschaft der Eisenverarbeitenden Industrie. Under this agreement the workers-up of rolled-steel products in Germany are enabled to get the raw material used in manufacturing for export as cheaply as if there were no import duty. The amount of the rebates depends on the margin between domestic and world market prices, which are determined each month by a Committee representative of the two associations and are based on the ruling f.o.b. Antwerp price.

Rationalisation of Production.

Co-operative control over market conditions and distribution, however, formed only one aspect of the policy of reconstruction adopted by the German iron and steel industry. An equally important aspect was the policy of rationalisation of production, which was carried out with remarkable speed and ability. It comprised the formation of large-scale undertakings for the purpose of developing mass output programmes so that the expensive equipment which had been installed could be kept occupied near to capacity, and thus operate on an economic basis; a high degree of standardisation; the introduction of labour-saving devices of all kinds; and the centralisation and concentration of production in the most economic and efficient plants—the ultimate aim being the cutting down of unnecessarily high overhead costs so as to increase efficiency and attain the highest economy of manufacture.

The formation of the Vereinigte Stahlwerke in the spring of 1926 was the most striking example of this aspect of rationalisation. Negotiations had been begun in the previous year between representatives of the five largest of the Rhenish-Westphalian works, the Thyssen, Krupp, Phœnix, Deutsche Luxemburg and Rheinstahl concerns, for some form of amalgamation. The Kloeckner, Gutehoffnunghütte, Hoesch, Mannesmann and Stumm concerns were also invited to participate, but decided to remain outside. Krupps also withdrew from the negotiations primarily because of the family nature of the concern.

In spite of numerous difficulties (one of which, the question of high taxation incident to a fusion of this kind, the Government mitigated by a reduction of the taxation involved), the Trust was formed and started operations on April 1, 1926, with a capital of £40 million. The Trust originally included the following works:—The Rhein Elbe Union, Thyssenwerke, Phœnix and Rheinstahl. The Trust comprised, *inter alia*, 85 blast furnaces, 27 converters and 157 open-hearth furnaces. It was allocated quotas of 22 per cent. of coal, 43 per cent. of pig-iron, and 41 per cent. of ingot steel in the respective syndicates. Soon after its formation the share capital of the Trust was supplemented by the proceeds of vast loans, placed mainly in the United States, which were destined to be expended on reconstruction and development of plant. By 1927 the Trust was operating with share and debenture capital, loans and reserves amounting in the aggregate to £87 million. The ordinary reserves amounted to about £4 million, and there was a special reserve of some £5 million for renewal of plant.

Obsolete Plants Scrapped.

During the three years of its existence the Trust has carried out a most comprehensive scheme of rationalisation in all departments, upon which upwards of £15 million has been expended. Inefficient and obsolete plant has been scrapped. Overlapping departments have been closed down, administration and technical direction has been concentrated, and new plant and equipment of every kind has been introduced so as to economise labour costs as far as possible. It cannot be denied that the result of this comprehensive policy of rationalisation has been successful. In spite of the many difficulties which have been encountered since its formation, and in particular the general shortage of capital and high interest rates in Germany, the Trust has consistently paid 6 per cent. dividend on its ordinary shares and has earned net profits averaging some 6½ per cent. of its share capital each year. In considering the value of these achievements, it should not be forgotten that each year the Trust has made substantial appropriations for reserves and amortisation, as a result of which its financial position at the present time is highly satisfactory.

The position of the Steel Trust has been dealt with in some detail because it offers a particularly good example of the rationalisation which has been introduced in the metallurgical industry as a whole. The other leading concerns, such as Krupps, Kloeckner, Gutehoffnunghütte, etc., have all adopted a similar policy, which has been largely responsible for the fact that financial results have, generally speaking, been highly satisfactory during recent years. Dividends have in the majority of cases averaged between 6 and 8 per cent., and, in addition, substantial appropriations from profits have been reinvested in the industry, with the result that a particularly strong financial position has been established.

Effect of Rationalisation on other Industries.

The rationalisation policy adopted by the steel industry played an important part in stimulating activity in the general engineering and building trades in Germany. It is realised, of course, that many factors contributed to the revival of industrial activity in Germany during the years 1925-27—not the least of which was the enormous amount of foreign borrowing which took place—but these factors could not have operated to the same extent had it not been for the fundamental changes which were made in organisation, administration and mechanical equipment, which made possible a reduction in costs and an increase in productive efficiency and enabled the metallurgical industries to take full advantage of the high level of activity in the home market.

It has already been pointed out that a close measure of co-operation in the field of distribution has been attained between the different producing units in the steel industry through the medium of the domestic syndicates, with the result that upwards of 90 per cent. of the industry is now controlled by one or other of these syndicates. It may be mentioned that the geographical localisation of the industry—some 80 per cent. of the total output is produced in the Ruhr district—has been a very important factor favouring the concentration of both production and distribution. At the present time some 70 per cent. of the steel industry is concentrated in the hands of five producers.

Co-operation of Labour.

It is hardly necessary to point out that the policy of co-operation on the part of labour was a potent factor assisting Germany's industrial recovery in the critical years following the economic and political disasters of 1923-24. The eight-hour day had been introduced in 1919 and continued until the end of 1923, when permission was given to revert to the two-shift system in order to assist the recovery from the effects of the Ruhr occupation. The workers made no opposition to the re-introduction of the two-shift system at the end of 1923 in circumstances which were generally admitted to constitute a state of national crisis, but it was inevitable that, when the industry was placed once more on a profit-earning basis, labour should turn its attention to the securing of improved conditions in the way of shorter hours and higher wages. The workers appealed for a return to the three-shift system when economic conditions improved, and an Order was made on January 20, 1925, requiring the return to the three-shift system at blast furnaces and coke ovens. Although the reduction in hours was limited in the first instance to blast furnaces and coke ovens, similar treatment could not long be delayed to the iron and steel industry in general.

It was not, however, until July 16, 1927, that the Federal Minister of Labour, after the denunciation of the collective agreement by the workers, decided to issue an Order providing for the introduction of the eight-hour day into the iron and steel industry generally as from January 1, 1928. In spite of the opposition of the employers, who desired the postponement of the Order owing to the many difficulties and additional costs involved, an arbitration award was issued at the end of 1927 which insisted on the re-introduction of the eight-hour day in the iron and steel industry generally as from January 1, 1928; but, in certain cases, postponements were granted so that in effect the Order did not come into full operation until some nine months later. During recent years substantial increases in wages have been obtained by the workers, attributable in part to the operation of the compulsory arbitration system and to the increasing strength and aggressiveness of the trade unions.

Compulsory Arbitration.

Towards the end of 1928 the workers demanded a further increase in wages of 1¼d. per hour, which was refused by the employers as being completely impracticable and unjustified by the economic situation of the industry. The employers rejected the arbitration award which was issued in October (in spite of the fact that it had been declared legally binding by the Minister of Labour), with the result that a stoppage occurred which lasted for five weeks. Finally, work was resumed at the beginning of December, and the Severing award, which was published later, granted increases varying from ½d. to ¾d. per hour for all time-workers over twenty-one years of age earning less than 11d. per hour. Both workers and employers were dissatisfied with the terms of this award, but there has been no further serious labour disturbance in the industry. With the decline in demand on the home market the employers have complained that the rigidity of wages under the compulsory arbitration system is uneconomic and is a serious handicap in competition with the franc-currency countries, where wages are at a much lower level. They maintain that the compulsory arbitration system, while making full provision for increases in wages during times of economic prosperity, is not successful in allowing for a necessary downward adjustment of wages when conditions are less favourable and when, owing to lack of demand and falling prices, it is essential that costs should be reduced.

Continental Steel Cartel.

Since 1925 the German steel manufacturers have exercised a substantial measure of conscious control over the domestic steel market. It was quickly realised, however, that the full benefits of such control could not be obtained without some sort of international agreement; for without some such agreement the restriction of output by the German steel manufacturers could be nullified by increasing production on the part of their foreign competitors. With a view to forming an international agreement, discussions took place at different dates between the steel interests in the Western European countries, and finally the Continental Steel Cartel agreement was signed on September 30, 1926, having for its object the restriction of output of ingot steel by the signatory countries. These were Germany, France, Belgium, Luxemburg and the Saar. After considerable discussion it was decided to take output during the first quarter of 1926 as the basis for the allocation of percentage quotas between the different member countries. The total quota for the first quarter of the Cartel's operation (September-December, 1926) was finally fixed at 29,287,000 tons, which was higher than the figure originally contemplated, but was considered to be justified owing to the loss of British production because of the coal stoppage in the United Kingdom during that year. The participation quotas of the different countries were allocated as follow:

Germany	...	...	...	43.18	per cent.
France	...	...	...	31.18	,, ,,
Belgium	...	...	...	11.56	,, ,,
Luxemburg	...	...	...	8.30	,, ,,
Saar	...	...	...	5.78	,, ,,

The regulations of the Cartel provided that fines were to be levied on all output in excess of the quotas allotted, and compensation was to be paid in cases where output was below quota, the accounts of penalties and allowances being made up each quarter.

It was agreed that each country should pay one dollar per ton of output to the expenses pool; that the penalties should be four dollars per ton on excess output, and that compensation was to be two dollars per ton up to a total deficiency of 10 per cent. of the quota. In the event of the deficiency exceeding 10 per cent. for several consecutive quarters, the tonnage on which compensation was payable was reduced by 2 per cent. for each successive quarter.

Cartel's Vicissitudes.

During its three and a-half years' existence the Cartel has passed through many vicissitudes. It has failed in its primary function of controlling output, for over-production has been general and not confined to one particular quarter or country due to particular conditions. The fines imposed have proved inadequate for their original purpose, as each country has regulated its output in accordance with prevailing market conditions and without paying any particular attention to the limitations fixed by the Cartel.

There can be no doubt that Germany, in her eagerness to reach some sort of international understanding with her Western competitors, accepted a formula which gave her an inadequate quota relative to her productive capacity. Even at the time of the formation of the Cartel, Germany maintained that, whereas the quota allotted to her amounted to only some 75 per cent. of her productive capacity, the quotas allocated to the other countries signing the agreement approximated to 95 to 100 per cent. of productive capacity. Germany in consequence has been heavily penalised, in spite of the fact that since the formation of the Cartel she has been granted various concessions in the way of reduced penalties on her excess home output and increases in her export quota. The penalty on her excess home quota (which was taken as 72 per cent. of the total) was first reduced from 4 dollars to 2 dollars per ton, and later to 1 dollar per ton. Germany, however, maintains that these reductions have not touched the crux of the problem, which lies in the wide disparity between her quota and her productive capacity, which is considerably more pronounced than is the case with the other member countries.

Cartel a Protection to Germany.

Germany has, on the other hand, derived certain benefits from the operation of the Continental Steel Cartel. The Cartel was instrumental in improving conditions on the German domestic market by preventing dumping on the part of France, Belgium and Luxemburg. By so doing it gave the German steel manufacturers breathing space whereby they were enabled to recover from their post-war losses and to put their concerns on a remunerative basis. As a result of the special agreement which was signed at the same time as the Cartel, and made dependent on it, imports of semis and finished rolled products from France and Luxemburg were not to exceed 6.5 per cent. of Germany's total consumption, competition on the German domestic market was restricted, and the German steel industry was able to reap the full advantage of the abnormally heavy demand during 1927-28 and to dispose of the bulk of its output at the comparatively high prices ruling on the domestic market. In addition, during this period the industry was operating at a rate near to capacity, and so was enabled to effect considerable reductions in its producing costs per unit of output.

The total quota of the Cartel was increased on two occasions last year: first on the basis of 2,000,000 tons per annum for the second quarter; and, secondly, on the basis of a further 1,000,000 tons per annum for the third quarter, the total

quota of the signatory countries then being 32,287,000 tons. As a result of the slump which occurred in October, however, a 10 per cent. restriction in production was introduced on November 1, and is still in existence.

The regulations provided that the agreement should terminate on April 1, 1931, but that on May 1, 1929, any country should be entitled to give notice of withdrawal from the agreement on October 1, 1929, in which case the other countries would be released from all obligations on the same date. No country took advantage of this provision last year, but it was generally understood that some modification of the existing regulations would have to be made if Germany were to continue her membership of the Cartel. The general position of the Cartel has been immensely strengthened by the formation of international organisations to deal with semis, sections, bars, heavy plates and hoops. These organisations are, for the time being, to confine themselves to general supervision over statistical questions connected with quotas, fines and compensation; and the different national producers or syndicates are to carry out the actual sales and to maintain contact with their customers. Information regarding sales booked will be communicated to the appropriate international organisation.

(To be continued.)

Solving Industrial Problems.

At the annual closing meeting of the Falkirk Iron Company's Welfare Club, Captain H. J. Kennard, R.N., managing director of the firm, who presided, in the course of his remarks said:—They had every reason for being pleased with their achievements during what was realised to be a very trying time in the industry. They were in the same boat as a great many other industries in this country, and that the state of things was spreading to almost every industry all over the world. A revolution of change was passing over all industry, and things were beginning to settle down. Unfortunately, the period since the war had been one of transition, and now they were hoping to take their chances as they might arise. One remarkable aspect of this question of industry was that in the ordinary way, industries, if one could call them such, which dealt with food before the war, imagined that their footing was secure and that they would never be troubled, but that was not the case at present. If the consumption was not sufficient to absorb what was produced, depression in industry was bound to follow as, for example, in the sugar industry in the West Indies. He thought the present position of industry was a matter which ought to be given very careful consideration; they would obviously require to find a way out of the position in which they found themselves at present. It had been stated in the Press that, generally speaking, the way out for manufacturing industries was to have a smaller number of units and to work more together. He himself believed that was the solution. They had already taken steps in that direction so far as the iron industry was concerned, and he was of the opinion that this would put their industry on its legs sooner than any other methods. If some such revolution in industry arose he was sure that the works which were best equipped and which had paid most attention to keeping abreast of the times would reap the benefit. They in the foundry were in a good position in this. Apart from the material side, they had always tried to foster what he might call fellowship, and this would in the end be a great asset to them. They were really in a bad way at the moment, but there were just little signs of improvement. They had been reduced to working only four days per week, but they looked forward to the time when they could increase it to five. They had at least faced the position and not run away from it.

Surface Combustion.

In a lecture delivered by Mr. M. V. Hurst, before the Junior Institution of Engineers recently, he described and demonstrated the Cox system of surface combustion, the invention of Prof. Bone. The system utilises gas from coal, petrol, etc., which, mixed with a correct proportion of air at a pressure of about 3 in. of water, is fed to "combustors" formed of a granulated material compressed into various shapes, on the surface of which the mixture burns without visible flame. For a few moments immediately after lighting, the surface of the combustor is covered with a thin film of blue flame, which gradually recedes below the surface of the combustor and raises it to incandescence. The "combustors" are contained in iron boxes, and a space is left between the underside of the combustor (which is about 1½ in. thick) and the back of the box into which the gas is led by the supply pipe. The "combustors" can be used in any position.

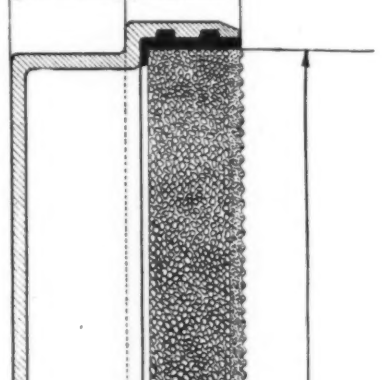

Fig. 1.

It was stated that by this system a much greater volume of gas can be consumed from a given area of burner than in any other, in some cases 750 B.T.U. per sq. in. of surface per hour are consumed; also there was no trace of carbon monoxide in the products of combustion and no excess air was required. The system had now been perfected, so as practically to preclude the possibility of back firing. The combustors are of two forms: flat, of any desired shape; and tubular, of any diameter between 3 in. and 5 in. outside and 3 in. long. These sections can be mounted into units of any desired length within practical limits, and can be made to fire either internally or externally—the former to heat articles placed inside the tubes and the latter for insertion into metal tubes forming the heating elements in fire-tube boilers, etc.

The pressure air required for combustion can be supplied by a small fan directly coupled to a very small electric motor. The motor for supplying air for the efficient combustion of 400 cub. ft. of gas per hour would consume about 120 watts, and in determining the efficiency of any "combustor" installation, or in comparing the results obtained with those where ordinary flame burners under natural draft were used, it was necessary to take into account the cost of obtaining the forced draft, and if gas be taken at 10d. a therm and electricity at 2d. per unit, the cost of compressing the air is equivalent to increasing the cost of the gas by only 1 to 1½ per cent. If a gas supply at 2 in. pressure and upwards is available, the necessity for forced draft is often eliminated, as the necessary air can be induced on the injector principle.

The pores of the "combustors" are not easily choked, but care should be taken to see that the air supply is dry and reasonably clean. If it becomes necessary to clean them, a bucket of very hot water poured over the face of the combustor readily clears it. If the choking is due to tarry matter in the gas the "combustors" cannot be cleaned. The normal life of a "combustor" was about three years, but many had been in use for five years.

Professor J. O. Arnold.

THE PASSING OF A GREAT METALLURGIST.

Metallurgists the world over will recognise that their science has lost one of its ablest masters by the death of Emeritus Professor John Oliver Arnold, whilst ex-students of the metallurgical department of Sheffield University will mourn the loss of an esteemed friend and teacher. Dr. Arnold was of the type of professor which unfortunately, owing to the rapid growth of specialisation, is rapidly disappearing. We refer to the ability they possessed of making relatively difficult material seem simple, and this associated with an impression that they were complete masters of their subject.

Whilst most people accord Prof. Arnold full recognition for his work on high-speed steel, the diffusion and migration of elements in steel, the influence of carbon on iron, we believe his greatest discovery was couched in a statement culled from notes we took when a student which reads: "A condition may be induced in mild steel through over-annealing, high phosphorus content and cold-working that it is completely plastic—that is, every ounce of stress imposed upon it will leave a corresponding amount of strain, and it is thus only a matter of time before fracture supervenes if utilised under dynamic conditions."

The importance of inducing a high-elastic limit condition in steel is becoming more and more recognised each year, and a recent modification in the design of ships is the direct outcome of this basic principle. In his capacity as head of the first metallurgical school in the world, Prof. Arnold permitted conditions of a Bohemian character to exist, possibly on account of the fact that students were drawn from all parts of the world, or maybe he appreciated enthusiasm more than discipline. That his method was a complete success is borne out by two related features. Primarily, we never remember a student "cutting" a single one of his lectures, and the majority of his old students now occupy positions of high responsibility throughout the metallurgical world. There was a certain shyness about his manner which one was apt to mistake for unapproachableness, but let a student get into a "scrape," as we occasionally did, they found in him a real friend. He evidently disliked most profoundly anything other than an atmosphere of mutual trust, and a reprimand was usually couched in the words: "Accidents will happen," or "If any damage has been done I will pay for it."

His academic distinctions included a Fellowship of the Royal Society, a Doctorate of Metallurgy of Sheffield University, and the award of the Bessemer Medal. Prof. Arnold was born at Peterborough in 1858 and was educated at King Edward's School, Birmingham. He occupied the Chair of Metallurgy at Sheffield from 1887 to 1919, when he was succeeded by its present occupant, Prof. C. H. Desch, F.R.S., who has since worthily maintained the traditions associated with that great school of metallurgy.

The name and fame of Prof. Arnold will for evermore be quoted by authorities throughout the world as a pioneer in the scientific metallurgy of steel and a thinker on definitely original lines.

Unsoundness in Bronze Castings.*

By Edward J. Daniels,† M.Sc.

Introduction.

The manufacture of sound castings of bronze, particularly the alloy known in Great Britain as Admiralty gun-metal (copper 88, tin 10, zinc 2 per cent.), presents some considerable difficulty, and, although many articles dealing with the various aspects of the problem have appeared in the technical Press of several countries, the real cause of many unsuccessful castings is still often doubtful.

In the present work an attempt has been made to solve the problem in two ways: (1) by applying existing knowledge to the melting and casting of the alloy, and (2) by examining the effect of various gases on small quantities of the alloy melted in small carbon or fireclay boats in a closed tube.

An extensive examination of the literature on this subject has been made, and the experimental results obtained in the present research have been examined in the light of the information so obtained, leading to a possible explanation of the phenomena observed.

Previous Work.

Karr and Rawdon have studied the effect of casting temperature, the character of the mould, and heat-treatment on the physical properties of the alloy. Their main conclusion was that the casting temperature has the greatest effect on the qualities of the casting whatever the type of mould. After studying a large number of castings they concluded that the bronze could be cast within a certain range of temperature, viz., 1,120 deg. to 1,270 deg. C., and possess satisfactory physical properties. If either extreme of this range were exceeded, the casting would be unsound and would show low strength and elongation in the tensile test. They found that most trouble was caused by the presence of oxide films and pits, which usually occur together with the eutectoid, and so cause great brittleness. Heyn and Bauer have shown that the tin oxide (SnO_2) is insoluble in molten copper-tin alloys, and that it is present in the solid either as crystals or as films. Karr and Rawdon found that the average density of their sand-cast specimens was 8.58, and of the chill-cast specimens 8.6. A fairly high percentage of their test-pieces, even when cast at a temperature within the safety range, gave bad results in the tensile test, and microscopic examination showed the presence of numerous "oxide films" in these specimens.

Carpenter and Elam confirmed the conclusion of Karr and Rawdon, that gun-metal cast above or below a certain range of temperature, 1,120 deg. to 1,270 deg. C., will be unsound. They also found that however much the metal may have been overheated, if cooled and cast at a temperature within the safety range, it will be sound. They say "the temperature (of casting) is all important, and provided that this can be regulated and controlled, there should be no difficulty about always obtaining sound castings."

Homfray and Adam have discussed the effect of remelting on gun-metal. They say that there is no doubt that virgin metal is the best, and that the zinc should be added as soon as the metal is melted. They discuss the range of pouring temperatures given by different authorities, who give the allowable pouring temperature as varying from 1,020 deg. to 1,270 deg. C. They say that "from our own experience we are of the opinion that the range of the best casting temperature for the 88: 10: 2 is entirely between 1,075 deg. and 1,175 deg. C., and that castings poured below the former will not be sound, and that separation will be produced in those cast above 1,175 deg. C. We are practically with Mr. Rolfe when he refers to 'no falling off till the metal has cooled down to about 1,060,' but we should have preferred to give the figure at 1,075."

F. W. Rowe holds somewhat opposite views to those just quoted. He says that "It is an understood fact that twice melted metal gives much stronger castings than virgin metal. It is a definite rule in the foundry with which the writer is connected never to exceed one-third virgin mix in the gun-metals. Heavy scrap is much better than virgin metal, provided that the composition is correct."

With reference to casting temperature, Rowe remarks that "the primary solidification sets in at 995 deg. C. ± 5 deg. C. Ten to 20-lb. crucibles are the best, as then the first box need not be cast at such a high temperature to enable the run to be completed. The casting temperature should never exceed 1,200 deg. C. for all normal work, and should preferably be lower. The writer has cast some tons of fairly small light-sectioned castings ($\frac{1}{2}$ in. to $\frac{3}{8}$ in.) at 1,110 deg. to 1,140 deg. C. with excellent results. Bars cut from these castings show regularly over 19 tons tensile strength and 18 to 22 per cent. elongation."

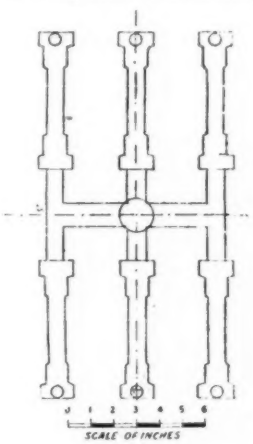

Fig. 1.

The effect of rate of solidification on the soundness of bronze has been studied by Sir John Dewrance, who has made a large number of highly instructive experiments, many of which are described in the Papers referred to. He indicates the dependence of the correct casting temperature on the type of casting being made, and emphasises the importance of temperature control to minimise the effects of the gas present in the molten metal. He is in agreement with the views of Genders that control of the gas evolution during solidification will reduce the extent of inverse segregation.

On studying the gas evolved by bronze when heated *in vacuo*, Carpenter and Elam found that a gas of approximately the same composition is present in both sound and unsound castings (both sand and chill). There was not a constant or sufficient difference in the volume of gas obtained from unsound and sound castings to account for the presence of blowholes in the one and their absence from the other. Their final conclusion is that "the most suitable practical way of avoiding porous castings would appear to be to determine the temperature of the alloy so as to ensure that it is poured within the range (1,270 deg. to 1,120 deg. C.)."

The negative result which these investigators obtained from the determination of the gas contents of sound and unsound metal confirms the results of Guillemin and Delachanal, who found that as much gas was obtained from sound as from unsound metal. However, there is one important point in this connection which seems to have some bearing on the question of unsoundness. All these observers find that sound metal contains much hydrogen with little carbon monoxide and carbon dioxide, whereas unsound metal contains important proportions of the oxides of carbon. This is in direct conflict with the work of Sieverts and Krumbhaar, who find that both carbon monoxide and carbon dioxide are insoluble in molten copper. However, Keizo Iwasé, working with a slightly modified form of apparatus, finds slight solubility of both these gases in solid copper and considerable solubility in the liquid state.

Hampe confirms the observations of Caron that copper, when melted and allowed to cool in a stream of carbon monoxide, gives unsound metal. On the other hand, Hampe finds that carbon dioxide has neither chemical nor physical action on copper, metal which has been cooled in the gas being perfectly sound.

Thus, the evidence regarding the solubility of the oxides of carbon in pure copper is very conflicting. As regards the solubility of gases in alloys of copper and tin the amount of information available is very small. Both Sieverts and Iwasé find that the addition of tin to copper lowers its capacity for dissolving hydrogen, and it has already been seen that several observers have extracted oxides of carbon from gun-metal.

The experiments of Röntgen and Schwietzke indicate that sulphur dioxide has no detrimental influence on bronze and may even lead to an increase in strength.

The effect of furnace atmosphere has been discussed by Woyski and Boeck, who lay great stress on correct furnace practice and indicate how spoilt metal may be recovered. They say that "Metal that has been subjected to bad melting practice, whether oxidised or gassed, may be brought back to normal conditions by proper furnace practice. In the case of oxidised metal a deoxidiser or flux is necessary. In the case of gassed metal, a strongly oxidising furnace atmosphere of a relatively high temperature, so as to produce quick melting, will correct the gassed condition. This has been proved many times. In one case, when, on account of a change in the furnace tender, several heats of red brass were gassed, all the castings were returned to the furnace and melted under the conditions just described, the resulting castings were entirely satisfactory, both as to fracture and microscopical characteristics." Again, "The most important cause of gassed metal is the atmosphere of the furnace. With proper regulation of air and fuel, it will not take place in the case of most non-ferrous alloys. It may be contrary to the general opinion, but we believe that an oxidising condition in the furnace is less troublesome than a reducing, provided that the bath is protected by a thin layer of mineral flux; also that it is more economical in time and fuel. The loss of metal is not appreciably greater. The mineral fluxes protect the surface of the metal and may replace deoxidisers in many cases, but to be certain of the removal of oxides, formed before the metal is melted, the metal must be stirred in order to bring the oxides in contact with the flux." They mention cases where metal which had been gassed in the furnace was remelted under oxidising conditions and protected by flux, and then gave perfectly sound castings.

Dews considers that melting in an oxidising atmosphere will lead to improvement in bronze, provided that casting and mould conditions are so arranged as to lead to efficient feeding.

It is improbable that the increased soundness obtained by melting under strongly oxidising conditions is due to the removal of the

* A Paper read before the Spring meeting of the Institute of Metals.

† British Non-Ferrous Metals Research Association, Birmingham.

soluble gases by direct oxidation, but that that can take place under certain conditions is shown by A. Portevin, who was troubled with unsoundness in gun-metal which was melted in an oil-fired furnace, in which the pressure of air could not be made sufficiently great and the atmosphere of the furnace was reducing. The bronze to be made called for 3 per cent. lead, so a suitable quantity of red lead was thrown on the surface, stirred in, and the metal cast with the usual precautions. As a result of this treatment the unsoundness disappeared completely. This treatment has been continued for some years, and has proved a complete remedy for the trouble. Portevin also found that many of the patent "dopes" made for obtaining sound castings contain oxide of manganese or some other oxidising agent.

Slow solidification of the metal in the crucible and remelting before casting has been found by Edwards and Prytherch to improve the density of copper. Archbutt applied this treatment ("presolidification") to an alloy of aluminium with a decided increase in soundness.

A list of further publications dealing with this subject will be found in the bibliography.

Present Work.

The experiments can be divided into two main groups:—

1. The casting of test-pieces from 20-lb. melts under various conditions, and the determination of the soundness and strength of the bars.
2. The study of the effect of treatment with pure gases on small quantities of bronze contained in a fireclay "combustion" boat.

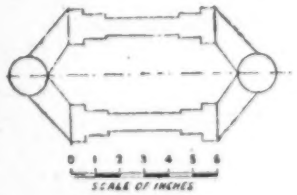

Fig. 2.

The data obtained may be conveniently classed under the following headings:—

1. Experimental Method.
2. Simple Melting.
3. "Degasification" with Phosphorus, Manganese and Nitrogen.
4. Presolidification.
5. Rate of Cooling (Type of Mould and Casting Temperature).
6. Effect of Furnace Atmosphere.

1.—Experimental Method.

Bronze of the composition 88:10:2 was made by melting together, in Salamander crucibles and under a thick layer of charcoal, virgin metals of high purity. Except in the case of the melts detailed in Table II a coke-fired wind furnace was used. The materials used were:—

Electrolytic copper (99.96 per cent. Cu) as cathodes.
Electrolytic zinc.
Chempur tin.

The copper was melted first, the zinc added and then the tin. When the whole charge was well mixed it was withdrawn from the furnace, cooled to the desired casting temperature, and cast into test-pieces, the moulds being of skin-dried green-sand and formed as shown in Fig. 1 for casting six pieces, or as in Fig. 2 when only two test-pieces were to be cast at one time. The specimens were allowed to cool in the sand overnight, and after density determinations had been made, they were machined to B.E.S.A. standard 0.25 in.² section and tested for tensile strength and elongations.

For studying the influence of pure gases on bronze the apparatus shown in Fig. 3 was used, the metal being melted in a fireclay "combustion" boat and cooled at any desired rate, after gas treatment, either by adjustment of the current in the heating element or by moving the silica tube relative to the heating element.

In all cases temperatures were measured by means of a platinum/platinum-rhodium thermocouple calibrated on a Cambridge portable millivoltmeter. The casting temperature should be taken as 1,120 deg. C. unless otherwise specified.

The densities of the test-pieces were determined by weighing in air and water at room temperature, giving the density compared with water at 15 deg. C. approximately. The small ingots produced in the boat melts were weighed in air and in water at known temperatures with counterpoised suspension and the density figures corrected to metal at 0 deg. C. and the water at 4 deg. C. (point of maximum density).

2.—Simple Melting.

When the bronze was simply melted and cast, using either virgin or scrap charges, the results shown in Table I were obtained.

Table I.—*Typical Results on Simple Melting and Casting at 1,120° to 1,150° C.*

Density. Grm./c.c.	Tensile Strength. Tons/in.²	Elongation. Per cent. on 2 in.	Charge.
8.46	16.18	18.8	Virgin metal.
8.74	15.84	11.6	,,
8·62	16.99	16.0	,,
8·63	17.88	20.5	,,
8.63	18.33	16.75	,,
8.70	15.53	10.8	,,
8.60	17.38	15.7	Scrap.

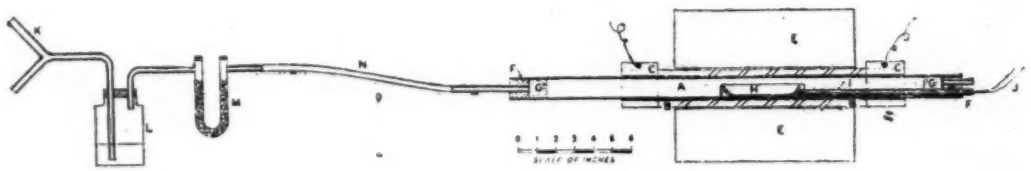

Fig. 3.

3.—"Degasification" with Phosphorus, Manganese and Nitrogen.

The opinion is largely held that the addition of small quantities of phosphorus and manganese to copper and its alloys results in increase of soundness. Table II illustrates the results obtained by adding these elements to Admiralty bronze. Table II also shows the effect of passing nitrogen (a neutral gas) through the molten alloy in an attempt to sweep out the gases causing unsoundness.

Table II.—*Treatment with Phosphorus, Manganese, and Nitrogen. Melting in a Small Town-Gas Injector Furnace.*

Density. Grm./c.c.	Tensile Strength. Tons/in.²	Elongation. Per cent. on 2 in.	Treatment.
8.67	17.72	18.5	Virgin metals. 0.04 per cent. phosphorus added to copper when melted.
8.58	17.60	18.5	
8.59	16.17	12.0	
8.62	15.06	15.5	
8.62	14.95	8.6	
8.56	17.42	19.5	Scrap metals. 0.04 per cent. phosphorus added before casting.
8.57	18.19	24.0	
8.56	15.70	10.0	
8.57	14.26	8.0	
8.56	15.60	12.5	
8.57	17.28	15.0	
8.58	—	—	Virgin metals. 0.05 per cent. manganese added to copper when melted.
8.64	—	—	
8.70	18.44	22.0	Nitrogen passed for ½ hr.
8.69	18.54	21.0	
8.69	15.32	10.0	Stand for 20 minutes and cast.
8.71	16.69	9.0	

No striking improvement was obtained as a result of these additions, whilst treatment with nitrogen further led to large loss of zinc.

4.—"Presolidification."

By "presolidification" is understood the slow solidification in the crucible of a metal or alloy followed by remelting and casting in the usual manner. Gun-metal subjected to this treatment has improved tensile properties, but its density remains unchanged, as will be seen from the results obtained, which are collected in Table III:—

Table III.—*Effect of Presolidification.*

Density. Grm./c.c.	Tensile Strength. Tons/in.²	Elongation. Per cent. on 2 in.	Treatment.
8.60	14.03	7.5	Scrap, melted and cast. (Heat S.)
8.58	17.10	16.0	
8.60	14.28	15.5	
8.63	18.31	24.0	Scrap, presolidified, remelted and cast. (Heat SA.)
8.59	18.88	27.5	
8.57	17.19	24.0	
8.70	17.09	16.0	
8.70	14.52	8.0	Virgin metals, melted and cast. (Heat CD.)
8.70	14.21	8.0	
8.68	16.48	12.0	
8.65	17.20	11.5	Virgin metals, presolidified. (Heat SC.) Cast 1,250° C.
8.59	18.35	16.0	
8.65	16.21	12.0	
8.62	16.67	12.0	
8.62	17.24	15.5	
8.67	18.91	18.0	Virgin metals, presolidified. (Heat SD.)
8.65	18.56	16.5	
8.66	18.62	17.0	
8.64	19.06	26.0	
8.64	17.36	19.0	Scrap metal presolidified. (Heat SJ.)
8.64	17.16	16.0	
8.63	17.92	21.0	

5.—Rate of Cooling.

In practice the rate of cooling, the casting temperature being constant, depends upon the size and shape of casting being poured, and the character of the mould if of sand or its thickness if a chill mould; if the mould is always the same it will depend upon the casting temperature. The effect of casting temperature with constant mould conditions is shown in Table IV.

Table IV.—*Effect of Casting Temperature.*

Density. Grm./c.c.	Tensile Strength. Tons/in.²	Elongation. Per cent. on 2 in.	Casting Temp. deg. C.
8.42	12.08	5.4	1,300
8.65	17.11	12.9	1,250
8.63	18.33	16.75	1,120
8.63	17.88	20.5	1,100

The effect of variation in the rate of solidification obtained by casting at constant temperature

Table V.—*Effect of Chilling.*

Metal.	Density. Grm./c.c.	
	Sand-Cast (Green-Sand).	Chill-Cast (Copper Button Mould).
Copper	6.81	8.47
,, ...	7.05	8.10
,, ...	6.94	8.19
,, ...	7.14	8.48
Copper plus 2 per cent. zinc	8.32	8.84
	8.28	8.78
,, ,, 10 ,, tin	8.11	8.74
Gun-metal, 88:10:2 ..	8.75	8.77

into metal chill and sand moulds is shown in Table V. The sand mould referred to in column

2 is illustrated in Fig. 2, whilst the chill mould was an assayer's button mould, made of copper, casting a button 2.5 in. in dia.

Thus the size of a casting, its general thickness, and the type of mould, green-sand, dry sand, or metal, will determine the best casting temperature to use.

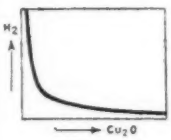

Fig. 4.

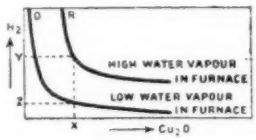

Fig. 5.

6.—Effect of Furnace Atmosphere.

To study the problem, two lines of attack were used:—

(1) Melting and solidifying 50-grm. charges in a stream of gas, using the apparatus shown in Fig. 3.

(2) Melting 10-lb. charges in a coke furnace with varying conditions of fire.

A.—Boat Melts.—The method employed was a modification of that used by Hampe in his classical experiments on copper. The weighed sample contained in a fireclay "combustion" boat was melted in a stream of the gas whose effect it was desired to study, and by adjusting the heating current or the position of the boat relative to the heating element the metal could be solidified at varying rates. The gases used were obtained from cylinders and dried by bubbling through sulphuric and chromic acids before entering the furnace.

1. *Effect of Nitrogen and Carbon Dioxide.*—Table VI shows the densities obtained by treatment for various times in a stream of these gases at 1,150 deg. C.

Table VI.—*Treatment with Nitrogen and Carbon Dioxide at 1,150° C. Constant Rate of Solidification (approx. 14 min.).*

Mark.	Gas.	Time of Treatment. Min.	Density.
VII	Sample of original scrap	—	8.689
I	Nitrogen	30	8.880
II	,, ...	30	8.880
IV	Carbon dioxide	10	8.852
V	,, ,, ...	20	8.881
IX	,, ,, ...	40	8.878
III	,, ,, ...	60	8.879
VI	,, ,, ...	100	8.880
X	Nitrogen (stagnant) ..	10	8.874

From these results it appears that both nitrogen and carbon dioxide act as neutral gases with respect to Admiralty gun-metal, and that, after all the soluble gases have been swept out, the metal solidified quite sound, even after it had been treated with carbon dioxide for 100 minutes, thus indicating very little, if any, chemical action between the bronze and carbon dioxide. The maximum density of the 88 : 10 : 2 alloy was taken from the above to be 8.88, and this is the figure which has been used in calculating the unsoundness of castings.

2. *Effect of Rate of Solidification in Hydrogen.*—It was anticipated that, in the case of hydrogen (which is soluble in liquid copper-tin alloys, but probably not in the solid alloys to anything like the same extent), variations in the rate of solidification might influence the density. To test the point the experiments detailed in Table VII were made, the rate of solidification being determined by taking temperature readings every 30 sec. during the cooling. Graphite boats were used in all melts except V, X, and AC, where a fireclay boat was used.

When the metal is saturated with hydrogen and allowed to cool in that gas the resulting ingot may or may not be sound. If the time taken to cool through the solidification range is 14 to 47 min. (or probably even longer) the ingot is sound. If the time of solidification, however, is between 4 and 1.25 min., the ingot is quite unsound. If a correspondingly rapid rate of solidification is employed, in nitrogen or carbon dioxide, the ingots are perfectly sound.

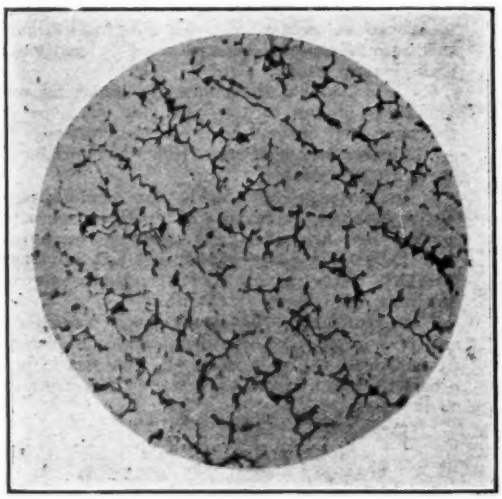

Fig. 6. × 100.

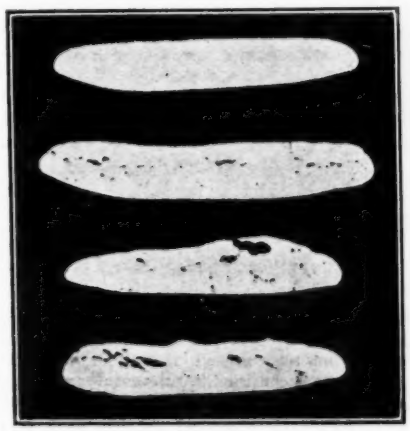

Fig. 7.

Figs. 6 and 7.—Unsoundness in Bronze Castings.

Table VII.—*Effect of Rate of Solidification in Hydrogen.*

Mark.	Time of Treatment at 1,150 deg. C. Min.	Gas.	Time of Solidification.*	Density.
X	20	CO_2	52 sec.	8.88
AC	20	,,	57 ,,	8.87
V	20	N_2	1 min. 12 sec.	8.91
AB	20	,,	0 ,, 56 ,,	8.87
I	30	H_2	47 min.	8.898
H	30	,,	30 ,,	8.888
G	30	,,	19 ,,	8.893
E	30	,,	16 ,,	8.907
F	30	,,	14 ,,	8.880
N	30	,,	3 min. 55 sec.	8.19†
L	30	,,	1 ,, 45 ,,	7.95†
M	30	,,	1 ,, 25 ,,	8.04†

* The time of solidification is the time taken for the charge to pass through the freezing range of the alloy (1,000 deg.—800 deg. C.), as indicated by a pyrometer fastened into the end of the boat close to the metal.

† These figures are probably somewhat high as the blowholes opened on to the surface in many cases, allowing water to penetrate the metal during the final density weighing.

The type of unsoundness obtained with hydrogen is shown in Fig. 7, which represents sections of ingots E, N, L and M. Ingot E is perfectly sound rate 16 min.). The others show holes of the same type as are formed in copper which has been rendered unsound by means of hydrogen, but it quite unlike that obtained in commercial casting, in which the holes are generally much smaller.

3. *Effect of Rate of Solidification in Carbon Monoxide.*—Table VIII shows the results when carbon dioxide is passed through the furnace, the metal being contained in a graphite boat. At 1,150 deg. C. the carbon dioxide and the carbon of the boat react to give relatively pure carbon monoxide.

Table VIII.—*Rate of Solidification in Carbon Monoxide.*

Mark.	Time of Treatment. Min.	Gas.	Time of Solidification.	Density.
B	10	CO	14 min.	8.887
D	25	,,	14 ,,	8.888
O	20	,,	1 min. 55 sec.	8.72
P	20	,,	0 ,, 29 ,,	8.64
T	20	,,	0 ,, 32 ,,	8.77
S	20	,,	0 ,, 35 ,,	8·74
AA	20	,,	1 ,, 12 ,,	8.76

Ingots O and AA showed numerous oxide films on micro-examination, but no blowholes. Further experiments with a 10 per cent. copper-tin alloy in carbon boats, using carbon monoxide prepared by the action of sulphuric on formic acid, gave similar results, densities varying from 8.67 to 8.85 being obtained. Examination of the specimens showed that in no case were any blowholes present, but that, whenever the density was low, the metal contained numerous oxide films. It is concluded, therefore, that the low density was due to oxide and not to carbon monoxide, since when oxygen was absent the ingots were perfectly sound (B, D). A typical oxidised area in specimen S is shown in Fig. 6 at a magnification of 100 dia. In view of these facts it must be concluded that carbon monoxide acts as a neutral gas towards bronze.

In both copper and bronze hydrogen gas alone is capable of producing unsoundness, which increases with increase in rate of solidification, and which can be avoided entirely by sufficiently slow cooling. Commercial unsoundness, on the other hand, in both copper and bronze is decreased by chilling (see Table V), and at the same time the blowholes are generally quite small and spherical, whereas the cavities produced by pure hydrogen in bronze (Fig. 7), and in copper are large and irregular in shape.

The type of unsoundness occurring in commercial copper has been reproduced by Allen by casting copper containing small quantities of oxygen and hydrogen. The quantity of hydrogen necessary to give this effect was found to be quite minute and could not be removed by inert gases, although, if oxygen were absent, treatment with inert gases before casting enabled sound ingots to be obtained.

Allen found that carbon monoxide was a suitable inert gas for copper, and experiments have shown that it is also inert to bronze. He obtained a typically practical unsound casting of pure copper by treating cathode copper with carbon monoxide at 1,150 deg. C. for 1 hr. and then casting (in the same atmosphere) into a warm steel mould, the copper entering the mould through a silica tube lined with copper oxide, which was picked up by the metal in its passage along the tube If the tube were clean and no oxidation of the metal occurred, the casting was perfectly sound.

Bearing in mind the similarity of results obtained with copper and bronze, detailed above, it was not unreasonable to suppose that a similar state of affairs might exist with bronze. Accordingly this experiment was repeated in Allen's furnace with a bronze containing 10 per cent. tin. No zinc was added as contamina-

tion of the furnace was undesirable. The ingot produced had a density of 8.28 and showed small globular blowholes and oxide streaks. The unsoundness of this casting was typical of that found in practice, and it suggested that the presence of both hydrogen and oxygen in molten bronze may be the factor which determines the production of unsoundness in practice. This seems to offer an explanation of the following results obtained by melting in varying furnace atmospheres and casting into sand moulds.

B.—Furnace Melts.—In these experiments, designed to study the effect of varying furnace conditions on the soundness of cast bronze, 20-lb. charges were melted in two distinct types of fire. First, a "reducing fire" in which the furnace hole was kept full of coke and the damper opened just enough to draw the products of combustion into the flue. Second, an "oxidising fire" in which the fuel bed was kept as thin as possible and the damper maintained full open, so that there was excess air passing through the fire. (Bamford and Ballard have found over 1 per cent. of hydrogen in the furnace atmosphere 10 min. after re-stoking.)

Table IX.—*Effect of Furnace Atmosphere* (*Casting Temperature of all Specimens*, 1,150 deg. C.).

Mark.	Density. Grm./c.c.	Percentage Unsound.	Tensile Strength. Tons/in.²	Elongation. Per cent. on 2 in.	Fire Condition.
KC2	8.110	8.9 (Cu 90) (Sn 10)	—	—	Reducing.
KF2	8.751	1.45	19.71	28.5	Oxidising.
KJ1	8.507	4.20	15.35	20.0	Partially oxidising.
KJ2	8.501	4.27	16.35	20.0	Partially oxidising.
KK1	8.669	2.04	18.14	20.0	Half previous charge presolidified.
KK2	8.739	1.62	6.24	13.0	Oxidising.
KL1	8.748	1.49	—	—	"
KL2	8.771	1.23	—	—	

In order to determine the unsoundness of the castings the specific gravity was determined by the method of Archimedes and corrected (reducing the figures 0.02 compared with previous ones) for temperatures of determination and then the percentage of voids calculated, using the following figures for the maximum density of the various alloys:—

Density of perfectly sound—	
Copper	8.942
Copper-zinc (2 per cent. Zn)	8.92
Copper-tin (10 per cent. Sn)	8.90
Copper-tin-zinc (88 : 10 : 2)	8.88

The first two of the above figures are due to Norbury, and the last two were obtained from the melts in carbon dioxide and nitrogen described above.

Table IX shows the results obtained for soundness and strength of the 88:10:2 alloy melted under the conditions indicated and cast in skin-dried green-sand moulds (as in Fig. 2).

These results indicate that the furnace conditions during melting of the alloy can be adjusted to give castings with a high degree of soundness or *vice versa* (KJ, density, 8.5; KL2, density, 8.77), and at the same time the "oxidising" condition does not lead to low results in the tensile test (*cf.* KF2, 19.71 tons and 28.5 per cent. elongation). At the same time, better results were obtained by simple melting in an oxidising atmosphere than by presolidification of the metal in a partially oxidising atmosphere, although compared with simple melting in a partially oxidising atmosphere, presolidification has resulted in increased soundness.

The influence of this change in fire conditions on pure copper was found to be negligible (see Table X), which also shows that the addition of tin to zinc does not render copper perfectly sound, *i.e.*, does not remove Cu_2O completely.

It is reasonable to expect that Allen's theory that unsoundness in copper is due to the reaction between oxygen and hydrogen (which he has supported with considerable experimental data) can be extended to cover the case of bronze. The fact that copper and bronze do not behave in a similar way with respect to variations in furnace atmosphere renders a modification of Allen's theory necessary before it can apply to bronze. The theory developed by Allen is based on the formation of steam from hydrogen and copper oxide absorbed in molten copper.

$$H_2 + Cu_2O \rightleftharpoons H_2O + 2Cu \quad \ldots\ldots\ldots (1)$$

In bronze, however, the Cu_2O is in equilibrium with tin and zinc according to the equations (2) and (3).

$$2Cu_2O + Sn \rightleftharpoons SnO_2 + 4Cu \quad \ldots\ldots\ldots (2)$$

$$Cu_2O + Zn \rightleftharpoons ZnO + 2Cu \quad \ldots\ldots\ldots (3)$$

But SnO_2 is assumed to be practically insoluble in molten bronze (2), and so is ZnO. If these assumptions are allowed, it will follow that their active masses in the liquid metal are constant. And, since copper, tin and zinc are constant, Cu_2O should theoretically be constant and independent of furnace atmosphere.

The relationship between the Cu_2O and H_2 in equilibrium in molten copper at a constant temperature is shown in Fig. 4 (after Allen) when the atmosphere surrounding the metal is constant (this follows from the Distribution Law). If the quantity of water vapour in the furnace atmosphere is low the curve will assume a position such as *O* in Fig. 5, and will be displaced to, say, position *R* (Fig. 5) if the atmosphere is high in water vapour. These two curves, *O* and *R*, can be assumed to represent the conditions with a thin coke fuel bed (*O*) and a very thick fuel bed (*R*), since coke often contains appreciable quantities of moisture.

But the assumptions made with regard to bronze fix the Cu_2O independently of variation in atmosphere. Let the quantity be represented by *X* in Fig. 5. Then with the two atmospheric conditions under discussion, the quantity of hydrogen in equilibrium in the molten bronze will be *Y* for "reducing fire" and *Z* for "oxidising fire"; in other words, there is more hydrogen to form water vapour in case *R* than in case *O*, and therefore an "oxidising" fire will give less unsound metal than a "reducing" fire. At the same time there is possibly free hydrogen in the atmosphere of the reducing fire which would tend to increase this effect.

It is possible than an explanation of the behaviour of bronze on melting and casting in the foundry will be found along some such lines.

Table X.—*Effect of Additions to Copper.*

Mark.	Composition. Copper. Per cent.	Tin. Per cent.	Zinc. Per cent.	Sand-Casting. Density.	Sand-Casting. Percentage Unsound.	Chill-Casting. Density.	Chill-Casting. Percentage Unsound.	Fire.
KA1	100	—	—	6.810	23.8	8.465	5.3	Reducing.
KC1	100	—	—	7.052	21.1	8.101	9.4	"
KD1	100	—	—	6.939	22.4	8.192	8.4	Oxidising.
KF1	100	—	—	7.142	20.1	8.476	5.2	"
KLA	100	—	—	7.318	18.1	—	—	"
KA2	98	—	2	8.324	6.7	8.836	0.95	—
KD2	98	—	2	8.238	7.1	8.784	1.5	—
KC2	90	10	0	8.110	8.9	8.767	1.8	—

Conclusions.

1. The observations of Karr and Rawdon, and Carpenter and Elam, with regard to the relationship between casting temperature and unsoundness of bronze have been confirmed.

2. Variations in casting temperature affect the rate of solidification, other conditions remaining constant, and similar variations in rate of solidification obtained by constant-casting temperature into moulds of different materials also affect the density of the castings in the same way.

3. Nitrogen, carbon dioxide and carbon monoxide have been found to be neutral towards bronze.

4. Hydrogen is capable of causing unsoundness in bronze at certain rates of solidification, and this unsoundness can be suppressed by treatment with neutral gases.

5. It is possible that normally occurring unsoundness is due to the combined presence of hydrogen and oxygen in the molten bronze. It is different in character from that produced by hydrogen alone.

6. Improvement in density of sand-castings can be obtained by melting in a pot-furnace with a thin fuel bed and good draught, compared with melting in a very thick fuel bed and poor draught. This is not so with pure copper to anything like the same extent.

7. Degasification with nitrogen, deoxidisers and presolidification gave negative results as far as improvement in density was concerned, but presolidification seems to increase the strength of the metal.

Reports and Dividends.

Swan, Hunter & Wigham Richardson, Limited.—Profit, £203,130; final dividend of 4½ per cent., making 7½ per cent. for the year.

Barrow Hematite Steel Company, Limited.—Profit for 1929 of £20,264, reducing the accumulated debit balance on profit and loss account to £38,802.

Sir William Arrol & Company, Limited.—Profit, £61,832; brought in, £21,391; preference dividend, £24,080; to special reserve, £38,972; carried forward, £20,170.

John Baker & Bessemer, Limited.—Profit, £19,121; brought in, £13,468; dividend of 4 per cent. on the ordinary shares; carried forward, £14,495.

P. & W. Maclellan, Limited.—Net profit, including balance brought in, £9,495; debenture interest, £6,750; balance, £2,745. No dividend on the preference shares.

Kerr, Stuart & Company, Limited.—Profit, £3,531; brought in, £40,934; interest on bank loan, and depreciation, £19,437; net loss, £15,905; carried forward, £25,028.

Vickers, Limited.—Net profit, £941,971; brought in, £217,704; preference dividend, £418,190; to reserve, £250,000; dividend of 8 per cent. on the ordinary shares; carried forward, £228,754.

Robey & Company, Limited.—Trading profit of £8,956, leaving a credit balance, after providing for debenture interest and other charges, of £439, which, deducted from the balance brought forward, reduces the total debit balance to £58,540.

J. Stone & Company, Limited.—Net profit, £263,964; brought in, £162,767; preference dividend, £39,000; to reserve, £50,000; dividend of 20 per cent., plus a bonus of 15 per cent., on the ordinary shares; carried forward, £127,592.

Rumbling *versus* Sand Blasting.

By J. A. Smeeton, M.I.Mech.E.

For a number of years the author has been interested in and closely associated with the use of modern sand-blasting machinery. During the last few years many leading British foundries and engineering works have installed sand-blasting machinery of various types, such as rotary drums for small castings, drop stampings, twist drills and small tools, rotary table machines for larger and more complicated castings, continuous roller table machines for larger castings, such as radiators, stove bodies, baths and the like, and lastly, chambers for large castings, in which the application of the sand-jet must be operated by hand.

Very radical improvements have been made in the construction of these machines, and the auxiliary details required to operate them and many new and interesting uses for sand blasting apparatus have been devised, such as the removal of paint, enamel and scale from railway carriages, plates, bars and tubes, and in most cases efficient economies have been obtained by the users.

A few years ago the Home Office introduced new factory regulations compelling closer attention for the alteration in relation to flying dust and sand which often comes from such machines, and more elaborate and efficient means of removing such dust by mechanical fan ejectors have been devised which completely solve this troublesome objection to the systematic and general use of such machines. It is now possible to install such machines in any workshop and be safe from any offensive flying dust of any kind, and in fact if efficient dust air-filters are used the cleaned air can be passed back into the workshop for warming or ventilating purposes.

In the past, in fact until quite recently, the author has looked upon all types of sand-blasting machines as a great advance over the old-fashioned rumbling machines, which in the majority of cases have only been used for cleaning the smaller castings, particularly in the malleable iron trades. Most foundries, however, have one or more rumbling barrels of various sizes, and they are all more or less crude and cheap in construction; clumsy and unwieldy in regard to power drive, and almost insufferably dirty and noisy during active work. Invariably they are belt driven through badly fitting open gears, and in many cases the drums are made with perforated barrels to allow the sand to fall out during working.

Little attempt has ever been made to fit any adequate form of dust suction or ejection to these barrels, because to do so in most cases would mean to envelop the whole machine in a dust tight chamber, which would be either too expensive or impossible owing to the limited space adjacent to the machines. In other words, any old cylinder shaped like a barrel made up of thin plate supplied with a filling door, which cylinder could be revolved by any means, has been passed for a rumbling barrel, and any old bits of broken castings have been used for circulating inside to clean the sand and scale off the castings. Such methods of rumbling have taken much time and have been and are still costly. The power consumption is invariably heavy owing to inefficiency through belts and bad bearing, and the maintenance costs must be very high. Of late years, however, various sizes of hardened cast-iron stars have been used in these barrels with beneficial results.

Having visited during the last twenty years hundreds of foundries in England and all over Europe, the author always felt annoyed with this noisy, dusty and crude method of cleaning, but he has always been impressed with the general clean state of the castings when they are removed from the barrels and with the comparatively small number of broken castings even when thin walled and delicate castings are being cleaned. One point of utility of rumbling, however, that has always impressed the writer is the minimum amount of handling which was necessary, namely, only that of actually filling and emptying the barrels, whereas with rotary-table sand-blasting machines and in chambers the castings have to be handled continuously to turn the many surfaces to the blast, all of which takes time and money, and even then often results in some corner or more or less inaccessible part being left uncleaned or imperfectly cleaned. Admittedly the surface finish of sand-blasted castings has a better appearance, but all such castings must be manhandled when cold.

Irish Foundry Exclusively Uses Barrels

Quite recently the author had the privilege of visiting a very large foundry in Ireland, where they are making some 150 tons of castings per day, and to his surprise this otherwise most modern foundry had no sand-blasting plant of any description. The castings and steel forgings produced and used in this works consisted of every detail required in the manufacture of motor cars, including cylinder blocks and wheels, and every single article was rumbled in some four dozen rumbling barrels of various sizes up to 46 in. dia. by 72 in. long.

These barrels stood in serried rows and were driven by long counter shafting and belt drives through noisy worm gears; each one filled to capacity with castings of all sizes and shapes. Each machine was connected to a centre dust extraction tube, so that there was very little if any dust flying about. The noise, however, was most unpleasant, and would have been far worse had not these barrels been made of substantial steel plates some $\frac{5}{8}$ in. thick. Expressing surprise at what he considered such a crude cleaning system in an otherwise wonderful foundry, the author was asked how he could improve upon it, and particularly upon the eventual result.

The time occupied in rumbling varied from $1\frac{1}{2}$ to $4\frac{1}{2}$ hours, according to the complication of the casting. Most of the castings were charged into the barrels whilst still hot from the moulds, and when the castings were eventually removed from the barrels they were still quite hot but had a perfectly clean surface, which surface owing to the annealing effect of the prevailing high temperature in the barrels resulted in an excellent machining surface.

Moreover, he was creditably informed that all casting strains were removed from the castings during these rumbling operations. This advantage certainly cannot be obtained by any known method of sand blasting. An extremely small amount of breakage occurs in this large multiple production foundry, either due to rumbling or from other causes.

Such is the belief of this firm in rumbling as the most efficient and economical method of cleaning castings that they are extremely shy of using any sand-blasting plant for any purpose for which rumblers can be used, and it must freely be confessed that efficient rumbling done in a really well-designed machine is just as economical and in other ways superior to the somewhat slow and more commodious sand-blasting machines now on the market, which require large-power air-compressors and other auxiliary details, all of which cost money and labour for maintenance.

As a final proof of this works' belief in rumblers, the author was informed that they had the immediate intention of purchasing a further dozen rumbling barreds 48 in. dia. by 78 dia. long of a new type, which is driven by a self-contained vertical motor mounted directly on the machine. The motor drives through a double threaded worm on to a bronze machine-cut worm-wheel, all of which gear is contained in a totally enclosed gear box filled with oil. The barrel trunnions are hollow and of large diameter and run in roller bearings. At one end the dust is sucked out through the hollow trunnion, thus rendering the machine quite dustless. It is also practically noiseless owing to the perfect gearing, and also due to the fact that the barrels are made of 1-in. thick plates. This machine can be reversed at will by the motor control switch, and thus the cleaning is speeded up and the output increased. The power consumption is also low owing to the direct-drive and the machine-cut gears. It is admitted that such a machine is high in first cost, but this is speedily amortised by saving in power, reduced maintenance, minimum space occupied, efficiency, high-class finished production, and no dust or noise.

Such a machine will go a long way to solve the cleaning problem, especially as it conforms to all the regulations of the new Factory Acts imposing dustless working. The whole question of the best method of cleaning castings must therefore be most carefully considered by every foundry when the bulk production of small and general castings is under consideration.

Washing Castings.

The best method of cleaning large and heavy castings, especially those containing large and complicated oil-sand cores, is a much more difficult problem. In the U.S.A. attempts have been made to clean out such cores with a combination of high pressure water jet at 300 to 500 lbs. pressure and steel shot or grit, but this method has not proved entirely successful up to now. In Germany considerable development has been made in the use of high-pressure water jets at up to 1,300 lbs. for iron castings and up to 2,000 lbs. pressure for steel castings. The author is assured that this method offers considerable economical advantages, inasmuch as castings can be cleaned and cores removed most cheaply, speedily and effectively, but he understands that the first cost of such a plant is very high, so that it would not pay unless it could be used continuously on a large output of work. Any device which can eliminate the present clumsy, dirty and dangerous methods of cleaning such castings by hand-operated sand-blast jets, either inside chambers or in special spaces, is well worthy of serious consideration, and a considerable amount of useful data is available to those interested, and, in fact, particulars of this process were printed in this Journal* quite recently.

[There is just one factor which the author has omitted, and that is a large variety of castings ejected from tumbling barrels requires hand-sorting, whereas from a rotary-table this work is much more easily accomplished.—Editor.]

Investigation of Quenched Steels.—The following is a synopsis of a Paper by Kanzi Tamaru in the Science Reports of Tohoku University. The magnitude of the A_0 transformation as observed magnetically was found to depend on the form of cementite particles. The change of etchibility of quenched steel in acids by tempering was also studied. The measurement of density of pure iron and carbon steel showed that steel tempered at 200 deg., which consists of beta-martensite only, was lighter than the annealed ones, but heavier than the quenched steel consisting of alpha and beta martensites. The density of plain austenite was obtained by studying manganese austenitic steels. The change of length of quenched steel tempered at different temperatures was measured. Electric resistance of austenite containing 0.5 per cent. of carbon at room temperature was also obtained.

* Foundry Trade Journal, January 23, 1930, page 65. "Tests on a Hydraulic Fettling Plant," by Prof. U. Lohse.

Visit to the Argus Foundry.

A party of over hundred members of the Scottish Branch of the Institute of British Fundrymen accepted the invitation of the directors of Messrs. Argus Foundry Company, Limited, to visit the works at Thornliebank last Saturday week.

The party were received by Mr. N. M'Manus, M.B.E., the works manager, and a number of his staff. Mr. M'Manus, in welcoming the members, said that he had decided to depart from the usual practice of dividing the party into groups to be marched round by a guide. All would be free to roam about as they desired and to ask for any information desired from the staff there for the purpose. Mr. M'Manus then gave a short account of the working and organisation of the foundry.

In order to assist the visitors in understanding the methods of working, a series of exhibits had been prepared, showing the stages in the moulding of certain castings. In the vicinity of each machine were placed cope and drag and a set of cores, also cores assembled, and boxes with cores in position ready for closing. A finished casting was shown by the side of the finished mould.

In the case of some of the larger castings produced by the firm, Mr. M'Manus had on exhibition a series showing the progress of production from the planning drawing to the finished article.

The plant for moulding and core-sand preparation was shown in operation, and a number of the moulding- and core-making machines were also being worked by members of the staff who had come out specially for the benefit of the visitors.

The party was entertained to tea in the canteen, when the Branch-President, Mr. H. Winterton, proposed that the best thanks of the Branch be accorded the directors of Argus Foundry, Limited, for having granted permission to the members to visit what was probably the most highly-organised foundry in Scotland, and also to Mr. N. M'Manus, the manager, and his staff for the efforts they had made to make the visit so interesting and instructive. He thought it would be obvious to them all that a great deal of time and trouble had been expended by Mr. M'Manus in organising the exhibits. Mr. J. Longden, immediate Past-President of the Branch, in seconding the vote of thanks, referred to the visit as unique and quite out of the ordinary type of works visits. The idea of showing each stage of the moulding process was one of the greatest value not only to the juniors but also to the senior members. Many things which they had been shown that day were revelations to the ordinary jobbing moulder, or even to many of them who had some experience of ordinary repetition work.

Mr. M'Manus, in replying to the vote of thanks, said it was a great pleasure to his directors and himself to be able to show what they could do to fellow-foundrymen. He hoped that everyone had had an enjoyable, interesting and profitable time and had been able to obtain all the information they desired. He would have much pleasure in conveying their expression of thanks to his directors, and on behalf of his staff and himself wished to say that it had been a pleasure to receive the members of the Institute, and the best thanks that could be offered was the knowledge that they had found the visit so interesting.

Corrosion of Metals and Alloys.—M. A. Portevin, in a recent issue of the "Revue de la Métallurgie," reviews recent work done in connection with corrosion, explaining in detail the nature and cause of the various types of corrosion of steel, copper alloys, and light alloys, and the numerous methods of studying the rate of corrosion and the value of protective coatings. Research directed towards the production of non-corrodible alloys, such as stainless steels, is discussed, with especial reference to the theoretical aspect of the subject.

British Engineering Standards Association.

The British Engineering Standards Association celebrated the granting of the Royal Charter of Incorporation to the Association by a banquet held at the Grocers' Hall, Princes Street, London, Mr. Maurice F. G. Wilson (chairman of the Association) presiding. The principal guest was His Royal Highness the Duke of York. Others present were Lord Thomson (Secretary of State for Air), Sir William Ellis, G.B.E. (member of Council), the Hon. Sir Charles Parsons, O.M., K.C.B. (member of Council), Colonel R. E. Crompton (member of Council), Mr. Evan Williams (President, Mining Association of Great Britain), Mr. H. J. Skelton, Sir Robert Hadfield, Bt. (member of Council), Sir Richard A. S. Redmayne (chairman, Advisory Council of Imperial Institute), Mr. Frank Hodges (Central Electricity Board), Sir William Larke (Director, The National Federation of Iron and Steel Manufacturers (member of Council)), Dr. F. E. Smith (member of Council).

His Royal Highness the Duke of York, proposing the toast of "The British Engineering Standards Association," said that he was glad to have that opportunity of identifying himself with the work which the Association was doing, for any public movement which assisted in maintaining British quality, combined with economy in production, must demand the attention of all thoughtful people and deserved the support of every branch of industry. Particularly was this the case at the present time, when the country's attention was being turned towards the imperative necessity of improving our trade position as the vital factor in bringing about more employment. Fortunately, the spirit of co-operation was to be found everywhere in industry to-day, and this was doing much to help a general reorganisation along the most modern, scientific and economic lines, without which no enterprise could flourish. The Association had laboured unceasingly to create and foster this spirit of co-operation and had achieved marked success in persuading the various branches of the great engineering and allied industries of the country to come together and unify and simplify their needs. His Royal Highness congratulated the Association most warmly on having obtained a Royal Charter and hoped that they would continue to prosper in carrying on their great national work.

The Chairman, in thanking the Duke of York for the great honour conferred on the Association by his presence, said that His Royal Highness had very appropriately dwelt on the spirit of co-operation which animated the work of the Association and the impartial manner in which it was carried out. It was a *sine qua non* that no British Standard Specification should be issued unless all were agreed that it fulfilled a generally recognised want. Under the Royal Charter the organisation had been brought thoroughly up to date, and the members had an opportunity of being elected to the Council and taking their proper share in the management of the affairs of the Association. Moreover, the community interest of producer and purchaser was maintained throughout the work.

Continuing, the speaker mentioned the increased financial support recently granted by the Government, which was due in large measure to the Report of the Committee on Industry and Trade, presided over by Sir Arthur Balfour. The Government grant was for £3,000 a year for five years, under conditions which the Association could readily fulfil. It was to be increased to a maximum of £5,000 a year depending on the Association obtaining certain increased support from industry, which it was confidently expected would be forthcoming. The speaker referred particularly to Mr. H. J. Skelton, an engineer and steel merchant, who in 1895 wrote to "The Times" in regard to the enormous variety of steel sections which then existed, and the great desirability of some standardisation being brought about. It would always be to the credit of the engineers of this country that they had the foresight to see that this work could only go forward successfully if it were on a fully co-operative basis of a national character, and had the full support of the Government behind it.

Mr. Ll. B. Atkinson (chairman of the Finance Committee) proposed the toast of the guests, and made particular reference to Lord Thomson (the Minister for Air) and also to Mr. H. J. Skelton, whom he considered as the real originator of the idea of standardisation in this country.

Lord Thomson replying, in the absence of the President of the Board of Trade, on behalf of the guests, paid a tribute to the very valuable work done by the Association. He mentioned the close contact maintained between Departments of State and the Association, Government officials participating in the work of many of the Committees through which the Association functioned. The Air Ministry, in particular, had reason to be grateful to the Association for its assistance in the matter of British Standard Specifications for purposes of aircraft, and he understood that the Home Office, the Admiralty, the War Office and the Ministry of Transport, amongst others, had made much use of, and derived great benefit from, the work of the Association.

Mr. H. J. Skelton said how much he appreciated the honour the Association had done him in inviting him to attend the banquet. It was true that about 1895 he had been very distressed with the enormous amount of capital which was locked up in the huge stocks, which turned over so slowly, that he urged that something should be done to release some of the locked-up capital, which might be more remuneratively employed elsewhere. In 1900 he read a Paper before the British Iron Trade Association, in which he advocated standardisation. He hardly, however, recognised the organisation as it stood to-day, so great had been its progress. Some day it would no doubt be even more truly national than it was at present. It was helping to equalise competitive conditions, to reduce waste of time and material, and the British Standards were valued not only in this country but throughout the self-governing Dominions and even outside the Empire. A good deal was heard to-day about the education of salesmen. British makers were unsurpassed in the quality of the goods they made, but our salesmen still left something to be desired. Mr. Skelton urged the various industries to make use of the Association to maintain quality through British Standards, and put these in the hands of all their salesmen at home and abroad. He hoped to see this national organisation increase in its usefulness to industry generally, and he wished it every success in the years to come.

Catalogues Received.

Electrodes.—Bulletin No. 61, published by Messrs. Alloy Welding Processes, Limited, of Forrest Road, London, E.17, is the best piece of publicity which has to our mind so far emanated from this firm. It details a number of interesting tests carried out in Edgar Allen's steel foundry, supplemented by some experiments carried out in Rome. In connection with the latter, we suggest that the figures could usefully have been converted from the metric system into avoirdupois.

Sheet-Metal Testing Machine.—List No. 1365, published by Messrs. W. & T. Avery, Limited, Soho Foundry, Birmingham, illustrates and describes the Avery sheet-metal testing machine (Haas Patent). This machine gives either a clamped or a slip distension test at will. It measures the thickness of the metal and the distended height of the sample under test by micrometer readings graduated 0.01 mm. for thickness and to 0.02 mm. for distension.

Gas-Fired Industrial Furnaces.—The Hearn Foundries (Luton), Limited, of Holly Street, Luton, Beds, have sent us a folder which details the Ionides Gas-Flame Control system of furnace control. The diagram of the balancing of the air and gas pressures is particularly interesting, and appeals to us as a very rational method of control, once the best ratios have been established. The illustrations of the melting and annealing show an intelligent appreciation of modern requirements, the design of the 300-lb. aluminium furnace being of a unique character. We would suggest that when printing copies of testimonials the names of other makes of furnaces should be deleted for such obvious reasons as date of installation and the like.

Mr. J. T. Goodwin, a past-President of the Institute of British Foundrymen, is shortly to visit the United States of America. Mr. Goodwin is foundry general manager of the Sheepbridge Coal & Iron Company, Limited, which possesses foundries ranking amongst the most important in England, covering heavy jobbing and pipe casting.

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Trade Talk.

The Metropolitan-Vickers Electrical Company, Limited, have removed their Leeds office to Permanent House, The Headrow, Leeds.

The address of the London office of the United Steel Companies, Limited, and their associated firms is now 16, Great George Street, Westminster, S.W.1.

The Vulcan Foundry, Limited, Newton-le-Willows, are to supply twenty locomotives to the Buenos Aires Great Southern Railway, at a cost of approximately £120,000.

A 40-ton Moll furnace, the first of its type to be erected in this country, was lit successfully at the Pontardawe works of Messrs. W. Gilbertson & Company, Limited. The output of this unit is estimated at over 800 tons per week.

A message from Sydney (N.S.W.) states that the Sydney Civic Commissioners have accepted the tender of Messrs. A. Reyrolle & Company, Limited, Hebburn-on-Tyne, for the supply of metal-clad switchgear for sub-stations. The firm's tender was £65,677.

Messrs. Quipcast, Limited, have removed from 119, Moorgate, London, E.C.2, to 86, Chandos House, Palmer Street, Victoria Street, London, S.W.1. Telephone No. : Victoria 7220. Mr. L. C. Pott is now the sole proprietor, Capt. Whiston having retired from the business.

Messrs. George Brown & Company, Limited, Greenock, have launched the steamer "Tenhir," of 1,600 tons deadweight, built to the order of Compagnie Nantaise de Navigation á Vapeur. Machinery is being supplied and installed by Messrs. M'Kie & Baxter, Limited, Glasgow.

Messrs. William Hamilton & Company, Limited, Port Glasgow, have launched the steel screw steamer "Cautin," which has been built to the order of the Compania Sud-Americana de Vapores, Valparaiso, for passenger and cargo service on the Chilian coast. The vessel is 350 ft. in length, with a breadth of 51 ft. and depth to upper deck of 24 ft., and of 4,000 tons deadweight capacity.

Contracts have been placed by the London & North-Eastern Railway for the construction of 79 new passenger coaches. Messrs. Craven's Railway Carriage & Wagon Company, Limited, are to build 14 vestibuled coaches, the Birmingham Railway Carriage & Wagon Company, Limited, 23 vestibuled coaches, and the Metropolitan-Cammell Carriage, Wagon & Finance Company, Limited, 32 vestibuled coaches and two five-coach suburban train sets.

Messrs. John Lewis & Son, Limited, Aberdeen, have launched a fishing vessel for the Soviet Government, acting through Messrs. Arcos, Limited, London. The vessel is of an experimental nature and the first to be built in Britain for the Soviet. Length between perpendiculars, 105 ft.; 21 ft. moulded breadth, and 11½ ft. depth. She has been specially stiffened for working in ice, and in addition to the usual trawling equipment is designed to operate as a herring drifter, and to be adapted for Seine net fishing. A sister vessel under construction will be launched shortly.

Messrs. Sandberg, of London and New York, who for many years have acted as consulting and inspecting engineers for a number of the Chinese railways, have received intimation of their appointment as honorary technical advisers to the Ministry of Railways of the National Government of the Republic of China. Messrs. Sandberg previously acted in a similar capacity to the late Ministry of Communications of the Chinese Government. It is hoped that, when political conditions improve, the necessary finance will become available for the reconditioning of China's railways and their considerable extension.

The annual meeting of the British Electrical and Allied Manufacturers' Association was held in London on Thursday, March 20. Lieut.-Colonel R. K. Morcom (Messrs. Belliss & Morcom, Limited) presided, both the chairman (Mr. V. Watlington) and the director (Mr. D. N. Dunlop) being absent owing to illness. It was announced that the following firms had been elected members of the Council :—British Electric Transformer Company, Limited, Metropolitan-Vickers Electrical Company, Limited, Micanite & Insulators Company, Limited, Nalder Brothers & Thompson, Limited, and Allen, West & Company, Limited.

Messrs. David & William Henderson & Company, Limited, Partick, Glasgow, launched a steel screw steamer built to the order of Messrs. H. Hogarth & Sons, Limited, Glasgow. The vessel is classed in the British Corporation, and is of the following dimensions :—Length, 350 ft.; moulded breadth, 50 ft.; depth, 25 ft. 9 in.; with a gross tonnage of 3,700. She is fitted with nine steam winches, which, with the derricks, afford ample means for rapid cargo handling. The machinery supplied by the builders consists of triple-expansion engines having cylinders 21½ in., 37 in., 62 in. and 42 in. stroke. Steam at 210 lbs. is supplied from two single-ended boilers.

Sir John Corcoran, director of the National Union of Manufacturers, in a letter sent to the Chancellor of the Exchequer, submits for Mr. Snowden's consideration, in connection with his forthcoming Budget, a number of proposals for the amelioration of the burden of taxation on manufacturing industry. Sir John draws special attention to inadequate income-tax allowances in respect of wear and tear and obsolescence of plant and machinery; the assessment of undistributed profits to super-tax; and the need for an allowance for income-tax purposes in respect of the cost of removing plant, etc., from one place of business to another, in cases where the removal is voluntary.

The Federation of British Industries point out that the lack of uniformity in the fundamental clauses of contracts is a matter which presents considerable difficulties to industry. Contractors and purchasers often find difficulty in agreeing upon mutually acceptable contract conditions, and clauses have frequently been put forward containing provisions of a nature inequitable to one or other of the two parties. In recognition of its importance, the F.B.I. have had this subject under review for some years, and as a result of their researches have now issued a series of standard fundamental clauses, which will apply to all contracts of a general nature. The clauses are submitted, they state, in the hope that their adoption will be to the advantage of all those concerned, whether suppliers or purchasers, and in the desire that they may be widely and generally used.

The local officials of the Amalgamated Engineering Union, in the latest report to the executive, state :—"Notwithstanding a slight decrease in the number of unemployed members reported by the branches, there are no visible signs of any improvement in the volume of employment. In shipbuilding, whilst some yards are moderately well supplied with work at the moment, the position in a few months, unless the unexpected happens in the meantime, will be far from satisfactory, as already members are being paid off at certain establishments. Overtime, however, the report states, is still being worked in connection with shipbuilding, ship-repairing, locomotive building, motor-car works and some other sections of industry. In Dundee the position is anything but bright, and during the last three months the engineering output is said to have been less than at any time during the past twenty years."

Obituary.

Mr. Henry Hall Bedford, of Sharrow Hurst, Sheffield, a well-known steel manufacturer and a former Master Cutler, died recently, aged 83.

Col. D. Ellis Williams, formerly director of the Panteg Steelworks of Messrs. Baldwins, Limited, and latterly managing director of the firm's Stourport works, has died at Brighton at the age of 75.

Mr. John William Trowsdale, of Saltwells House, Brierley Hill, managing director of the Earl of Dudley's Round Oak Works, Limited, has died at the age of 60. He was an outstanding figure in the Midland iron and steel trade, and was a member of the Birmingham Exchange and the Staffordshire Iron and Steel Institute.

New Companies.

Foundry & Engineering Company (West Bromwich), Limited, 104, Sandwell Road, West Bromwich.—Capital £15,000. Directors: A. Turner and W. H. Smith.

Samuelson & Company, Limited, Britannic Works, Banbury, Oxon.—Capital £10,000. General and agricultural engineers, etc. Directors: H. J. Butterfield and V. J. L. Doubleday.

Wm. Murrell & Company (1930), Limited, 237, Walworth Road, London, S.E.—Capital £5,000. Iron and brass founders, etc. Directors: H. Doyle, G. Arnott, E. H. Doyle and C. H. Murrell.

Personal.

Mr. T. H. Turner has been appointed chief chemist and metallurgist to the London & North-Eastern Railway Company, in succession to the late Mr. H. H. B. Jenkins.

Mr. P. B. Brown, J.P., joint managing director of Messrs. Hadfields, Limited, has been appointed deputy-chairman of the company. Mr. Brown is Senior Warden of the Cutlers' Company.

Mr. G. H. Johnson, late of Middlesbrough, who has been the general manager of the Kettering Iron & Coal Company, Limited, Kettering, Northamptonshire, for the past six years, has been appointed managing director of the company.

Mr. E. W. Fraser Smith, secretary of the North-East Coast Institution of Engineers and Shipbuilders, left Liverpool on March 24 for New York and Washington, where he is to represent the Institution at the 50th anniversary celebrations of the American Society of Mechanical Engineers.

Mr. R. Kidston, managing director of the Callendar Iron Company, Limited, Falkirk, has resigned in order to take up a similar position with Messrs. Bennets Foundry Company, Limited. Prior to his appointment at the Callendar Company, Mr. Kidston was for many years general works manager of the Falkirk Iron Company, Limited.

Mr. Andrew Laing was presented with the diploma of Honorary Fellowship of the North-East Coast Institution of Engineers and Shipbuilders on March 21. Mr. Laing, who is general manager of the Wallsend Slipway & Engineering Company, Limited, designed the engines for the Cunarder "Mauretania." Sir Archibald Ross, in making the presentation, said that no engineer had done greater, better and more progressive work in marine engineering than Mr. Laing.

Wills.

Ross, James, a director of the Victoria Brass Foundry Company, Limited, Leith £29,233

Company Meetings.

International Aluminium Company, Limited.—The annual meeting was held in London on March 24. Mr. Kenneth Clark (chairman), in moving the adoption of the report and accounts, said: Trading conditions, both in home and foreign markets, have been none too favourable and very severe competition has had to be faced. The market price for metal during the period under review did not improve, and the same conditions still exist. Nevertheless, there is a substantial trading profit. The accounts reflect the benefits derived from doubling the output of aluminium at our associated company's works in Norway, which during the year under review, made profits sufficient to write off a large portion of its preliminary expenses. Our alumina works at Hebburn-on-Tyne have been producing alumina at full capacity at reasonable costs.

British Insulated Cables, Limited.—The annual meeting was held on Friday, March 21, in Liverpool. Mr. D. Sinclair (chairman of the company), in his address to the shareholders, said that during the year they had practically completed the track electrification of the main line of the Great Indian Peninsula Railway. They had also practically completed the Scottish overhead "grid" system for the Central Electricity Board, and many of the lines were in use. Of new work in hand, a large extension of the super-tension cable work for the London Power Company, an underground trunk telephone line for the Post Office from Manchester to Chester, and an overhead connecting link between the national "grid" system and the new Clarence Dock Power Station for Liverpool were worthy of special mention. Their factories were generally well employed. During the past year a large number of process improvements had been introduced. A considerable extension of plant had been made for the production of aluminium wire, for which they had large orders in hand. Also extensions were in progress for the making of condensers and enamelled wire. They were also putting down plant for the manufacture of "Rockbestos" wire, for which they had obtained world rights, outside the two Americas. This was an insulated conductor, especially suitable for use in situations where permanence in high temperatures was a desideratum.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—It is, of course, too early as yet to offer anything like an accurate estimate of the ultimate effect of the recent drastic cut in Cleveland pig-iron prices, but it may be safely assumed that so far the result has been satisfactory in stimulating home demand, with consequent fairly heavy buying on forward account. Naturally, what is really desired and hoped for by makers is a steady flow of orders from week to week. The past week's spurt has manifestly been chiefly due to the placing of business which had been accumulating during the pause which preceded the revision of prices. And the steady day-to-day requirements of industry cannot yet be accurately assessed. As an immediate outcome of the reduced prices, better business with Scotland is anticipated. Of late there has been a number of cargoes of French foundry iron arriving in Scotland, in addition to still larger quantities of Indian basic pig. Local consumers are buying a little more freely, and there are indications that a few outlets may be found for Cleveland iron in neutral markets. Current quotations are:—No. 1 Cleveland foundry iron, 70s. per ton; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

Compared with the sudden drop of 5s. per ton in Cleveland foundry pig, prices of East Coast mixed numbers are confined to weekly reductions of only fractional amounts, having the effect only of intensifying the caution of consumers in regard to purchases. They will only buy for pressing needs, and for every order there is the keenest competition. The current quotation, however, is 75s. 6d. for mixed numbers, with 6d. extra per ton for No. 1 quality. On the North-West Coast, Bessemer mixed numbers are quoted at 76s. to 79s. per ton at works.

LANCASHIRE.—Failing disclosure on the part of the Midland ironmasters supplying local consumers of their future policy with regard to prices, markets for foundry pig in this area continue stagnant. With regard to current consumption, deliveries of iron to works in this area are below the level of the end of last year, and on the whole cannot be described as other than moderate. In the meantime Derbyshire and Staffordshire No. 3 brands are quoted at 77s., with Scotch pig-iron unchanged at around 95s., all per ton delivered local stations.

THE MIDLANDS.—Viewed from a general standpoint, the ironfounders in the Black Country district are suffering from a shortage of business, and are not prepared to buy except for current requirements. Nothing will induce them to buy forward, and the general opinion is that by holding out in this manner they will in the end achieve the result of getting down prices. Meanwhile, the furnaces are quoting 75s. for Northants No. 3 and 78s. 6d. for North Staffordshire and Derbyshire No. 3, including delivery to local stations.

SCOTLAND.—The market for Scottish pig-iron continues dull. Some of the makers say that they are able to dispose of the bulk of their output, but others complain that they are quite unable to manage this. There is no change in prices, and No. 3 Scotch foundry remains at the official minimum of 78s. per ton f.o.t. furnaces.

Finished Iron.

Manufacturers of this class of material in the Black Country districts are experiencing only a moderate demand for their products, and it is only in connection with marked bars that there is any substantial inquiry. The price of marked bars is £12 10s. at works and the makers are fairly well engaged. With regard to crown bars, the works are quite unable to get sufficient business to keep the mills going with any degree of regularity. Orders which are coming through from consumers and stock warehouses are not of an important nature. Quotations still fluctuate considerably, varying from £10 to £10 7s. 6d. The price of local nut and bolt iron continues in the region of £9 to £9 7s. 6d. Here, again, makers are poorly supported by consumers, but in this case the reason is foreign competition, the bulk of the business being placed by consumers in this area going to the foreign works.

Steel.

Considerable irregularity still persists in the position of the British steelworks, and, whilst a few have moderately-filled order-books, others have had to close down departments owing to lack of work. At Sheffield the official basis price of file-steel billets has been restored to £10 10s., the reduction some time ago to £9 15s. having, it is stated, proved to be unremunerative. Basic-steel billets continue to be almost the only active feature, the call for acid billets being very restricted, in spite of the cutting of prices. There is a fair market for wire rods. Tool steel is experiencing heavy Continental competition, and a good deal of this imported material seems to be finding its way into the Sheffield area. Prices:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium, £7 12s. 6d. to £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; acid wire rods, £12 5s. to £12 10s.; basic wire rods, soft, £8; medium hard, £9 15s. to £10; hard, £10 10s. to £11. In the tinplate market prices remain steady, coke qualities being quoted at 18s. 3d. to 18s. 6d. basis, net cash, f.o.b. Welsh ports.

Scrap.

Reports from the various market centres for foundry scrap material indicate continued depression, and in most cases some easing in quotations. At Middlesbrough sales have been very small for a couple of months past, and, as stocks have been accumulating on merchants' hands, they are becoming increasingly anxious to find an outlet. There is no display of activity at the local foundries, and the demand for good cast-iron machinery scrap remains slow at 60s. to 62s. 6d. In Scotland the position in the iron scrap market, so far as deliveries are concerned, has not improved Merchants are finding it difficult to dispose of stocks, and prices generally are easier. Current quotations rule as follow:—Heavy machinery qualities, 68s. 6d.; ordinary, 64s.; railway chairs, 67s. 6d.; and light cast iron, 58s. 6d., all per ton, delivered local consumers' works.

Metals.

Copper.—A steady upward tendency in values was marked in last week's movements in warrant copper, which may be attributed to renewed manipulation with a view to the maintenance by the copper combine of the present inflated price. Market opinion is extremely doubtful whether the combine will achieve its aim, but there is no doubt at all that the policy is inflicting harm to general trade in the metal. Prices have since fallen.

Closing quotations:—

Cash.—Thursday, £71 10s. to £72; Friday, £71 12s. 6d. to £71 15s.; Monday, £71 to £71 5s.; Tuesday, £70 5s. to £70 7s. 6d.; Wednesday, £69 18s. 9d. to £70.

Three Months.—Thursday, £68 5s. to £68 15s.; Friday, £68 5s. to £68 10s.; Monday, £68 5s. to £68 7s. 6d.; Tuesday, £68 13s. 9d. to £68 16s. 3d.; Wednesday, £68 10s. to £68 12s. 6d.

Tin.—The position in the market for standard tin continues unsatisfactory, although values, on the whole, have recovered from the recent depression. Sentiment in the market is rather more confident, probably due to the easier monetary conditions. There also appears to have been some outside buying, and this support has no doubt had a great deal to do with the better level of values.

Official closing prices:—

Cash.—Thursday, £168 7s. 6d. to £168 10s.; Friday, £169 15s. to £170; Monday, £170 10s. to £170 15s.; Tuesday, £166 7s. 6d. to £166 10s.; Wednesday, £165 2s. 6d. to £165 5s.

Three Months.—Thursday, £170 to £170 2s. 6d.; Friday, £171 5s. to £171 10s.; Monday, £172 2s. 6d. to £172 7s. 6d.; Tuesday, £168 2s. 6d. to £168 5s.; Wednesday, £166 17s. 6d. to £167.

Spelter.—Some improvement in the tone of the spelter market was noted, due, in the main, to anticipations regarding the renewal of the Cartel arrangements. Nothing has come so far of the conversations which are understood to have been proceeding, but sellers have adopted a somewhat reserved attitude. Actually demand has decreased, if anything, and late prices register a fall.

Daily quotations:—

Ordinary.—Thursday, £18 12s. 6d.; Friday, £18 11s. 3d.; Monday, £18 8s. 9d.; Tuesday, £18 2s. 6d.; Wednesday, £18 7s. 6d.

Lead.—Prices show an improvement since the last report, and altogether the market has a stronger tone. A considerable tonnage has been sold to consumers. Demand has come both from this country and from the Continent.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £18 17s. 6d.; Friday, £18 16s. 3d.; Monday, £18 16s. 3d.; Tuesday, £18 16s. 3d.; Wednesday, £18 15s.

On the Nature of Martensite Crystals.—Prof. Kotarô Honda, in a Paper published in the Science Reports of the Tohoku University, deals with the nature of the martensite, especially with its two kinds, alpha and beta, the existence of which is now made very evident by X-ray investigation. The formation of these martensites was explained by the theory of quenching put forward some ten years ago. A new view regarding the mechanism of tempering of quenched steels was also expressed. The broadening of the spectral lines of martensites was explained by the distortion of the iron lattice due to the presence of carbon atoms within the lattice.

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Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency in the foundry.

STERLING BOXES WILL SAVE THEIR COST IN A FEW MONTHS.

WRITE FOR CATALOGUE No. 37.

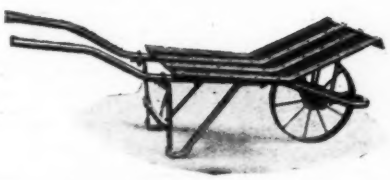
Sterling

FOUNDRY BARROWS

for

SAND, COKE, and PIG-IRON

are sturdily built to withstand the heavy duties and harsh treatment of the severest foundry service.



STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone: 3345 BEDFORD.
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

Glasgow: ALBERT SMITH & CO., 60, St. Enoch Square, GLASGOW, C.1.
Newcastle-on-Tyne: LAWSON, WALTON & CO., LTD., Handyside Arcade, NEWCASTLE-ON-TYNE.
Manchester: F. L. HUNT & CO., Chapel Street, SALFORD, MANCHESTER.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	69	18	9
Three months	68	10	0
Electrolytic	83	10	0
Tough	75	0	0
Best selected	75	10	0
Sheets	110	0	0
India	91	0	0
Wire bars	84	5	0
Do. April	84	5	0
Do. May	84	5	0
Ingot bars	84	5	0
H.C. wire rods	86	7	6
Off. av. cash, March	69	5	10⅝
Do., 3 mths., March	67	13	2 13/16
Do., Sttlmnt., March	69	5	11⅝
Do., Electro, March	83	16	6½
Do., B.S., March	76	11	3
Do., wire bars, March	84	5	0
Aver. spot price, copper, Mar.	69	5	10⅜
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11½d.

BRASS.

Solid drawn tubes	12½d.
Brazed tubes	14½d.
Rods, drawn	12½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	165	2	6
Three months	166	17	6
English	166	5	0
Bars	168	5	0
Straits	167	7	6
Australian	166	7	6
Eastern	173	5	0
Banca	169	2	6
Off. av. cash, March	164	19	0½
Do., 3 mths, March	167	0	2½
Do., Sttlmt., March	164	19	2
Aver. spot, March	164	19	0½

SPELTER.

	£	s.	d.
Ordinary	18	7	6
Remelted	17	2	6
Hard	15	5	0
Electro 99.9	20	7	6
English	18	10	0
India	16	5	0
Zinc dust	25	10	0
Zinc ashes	5	0	0
Off. aver., March	18	11	1½
Aver., spot, March	18	6	0½

LEAD.

	£	s.	d.
Soft foreign ppt.	18	15	0
English	20	10	0
Off. average, March	18	17	5 9/16
Average spot, March	18	16	1½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	28	0	0
Do. V.M. ex-whf.	26	10	0
Rods	30	0	0
Boiler plates	24	10	0
Battery plates	25	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	0	0
Chinese	29	10	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	17	6
45/50%	11	10	0
75%	19	5	0
Ferro-vanadium—			
35/50%	12/9 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%	3/- lb.		
Tungsten metal powder—			
98/99%	3/3 lb.		
Ferro-chrome—			
2/4% car.	£30	10	0
4/6% car.	£23	12	6
6/8% car.	£22	12	6
8/10% car.	£22	5	0
Ferro-chrome—			
Max. 2% car.	£33	15	0
Max. 1% car.	£38	2	6
Max. 0.70% car.	£40	15	0
70% carbon-free	11d. lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£11	15	0
76/80% packed	£12	15	0
76/80% export	£12	5	0
Metallic manganese—			
94/96% carbonless	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	2
Finished bars, 18% tungsten	£0	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	5	0	to	3	6	0
Bundled steel and shrngs.	2	19	0	to	3	3	6
Mixed iron and steel	2	17	6	to	3	0	0
Heavy cast iron	2	19	0	to	3	0	0
Good machinery for foundries	3	0	0	to	3	2	6
Cleveland—							
Heavy steel					3	0	0
Steel turnings					2	12	6
Cast-iron borings					2	8	0
Heavy forge					3	14	6
W.I. piling scrap					3	10	0
Cast-iron scrap	3	1	0	to	3	4	0
Midlands—							
Ord. cast-iron scrap					3	5	0
Heavy wrought					4	0	0
Steel turnings					2	0	0
Scotland—							
Heavy steel					3	5	0
Cast-iron borings					2	10	0
Wrought-iron piling					3	19	0
Heavy machinery					3	8	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	58	0	0
Brass	42	0	0
Lead (less usual draft)	16	10	0
Tea lead	12	10	0
Zinc	11	0	0
New aluminium cuttings	64	0	0
Braziery copper	54	0	0
Gunmetal	54	0	0
Hollow pewter	120	0	0
Shaped black pewter	87	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	76/-
Hematite M/Nos.	75/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/6
,, d/d Birm.	95/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	74/6
,, No. 3 fdry.*	78/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/-
,, fdry. No. 3*	75/-
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	80/6
,, No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	69/6
,, fdry. No. 3	73/6
Lincs. forge.	71/6
,, fdry No. 3	75/6
E.C. hematite	89/-
W.C. hematite	88/6 to 91/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	73/-
,, fdry. No. 3	77/-
Staffs foundry No. 3	77/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	95/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/-
Monkland, No. 3	95/-
Shotts, No. 3	95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	5	0	to	10	15	0
Nut and bolt iron	9	0	0	to	9	7	6
Hoops	10	15	0	to	11	5	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	15	0	to	11	5	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	17	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)					8	2	6

and upwards

Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy					8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to	9	15	0
Black sheets, 24 g.					9	15	0
Galv.cor.shts., 24g.	11	17	6	to	12	0	0
Galv. fencng wire, 8g. plain					12	0	0
Billets, soft	6	2	6	to	6	12	6
Billets, hard	7	10	0	to	8	0	0
Sheet bars	5	15	0	to	6	5	0
Tin bars	5	15	0	to	6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/3½
Sheet to 10 w.g.	1/4½
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	33.00
Sheet bars	33.00
Wire rods	38.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.30
Sheets, blue an'l'd, No. 13	2.25
Wire nails	2.25
Plain wire	2.40
Barbed wire, galv.	2.95
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6 to 30/-
,, furnace	17/6 to 22/6
Durham and Northumberland—	
,, foundry	15/6
,, furnace	17/-
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		18/3
,,	28×20 ,,		37/-
,,	20×10 ,,		26/6
,,	18¾×14 ,,		19/3
C.W.	20×14 ,,		16/-
,,	28×20 ,,		34/3
,,	20×10 ,,		23/6
,,	18¾×14 ,,		17/-
Terneplates	28×20		32/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	Fittings.
Gas	65%	47½%
Water ..	61¼%	42½%
Steam ..	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Mar.	27 ..	71	10	0	inc. 12/6
,,	28 ..	71	12	6	,, 2/6
,,	31 ..	71	0	0	dec. 12/6
April	1 ..	70	5	0	,, 15/–
,,	2 ..	69	18	9	,, 6/3

Electrolytic Copper.

		£	s.	d.	
Mar.	27 ..	83	5	0	No change
,,	28 ..	83	10	0	inc. 5/–
,,	31 ..	83	10	0	No change
April	1 ..	83	10	0	,, ,,
,,	2 ..	83	10	0	,, ,,

Standard Tin (cash).

		£	s.	d.	
Mar.	27 ..	168	7	6	dec. 2/6
,,	28 ..	169	15	0	inc. 27/6
,,	31 ..	170	10	0	,, 15/–
April	1 ..	166	7	6	dec. 82/6
,,	2 ..	165	2	6	,, 25/–

Tin (English ingots).

		£	s.	d.	
Mar.	27 ..	169	5	0	No change
,,	28 ..	171	0	0	inc. 35/–
,,	31 ..	171	15	0	,, 15/–
April	1 ..	167	10	0	dec. 85/–
,,	2 ..	166	5	0	,, 25/–

Zinc Sheets (English).

		£	s.	d.	
Mar.	27 ..	28	0	0	No change
,,	28 ..	28	0	0	,, ,,
,,	31 ..	28	0	0	,, ,,
April	1 ..	28	0	0	,, ,,
,,	2 ..	28	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Mar.	27 ..	18	12	6	No change
,,	28 ..	18	11	3	dec. 1/3
,,	31 ..	18	8	9	,, 2/6
April	1 ..	18	2	6	,, 6/3
,,	2 ..	18	7	6	inc. 5/–

Lead (English).

		£	s.	d.	
Mar.	27 ..	20	10	0	No change
,,	28 ..	20	10	0	,, ,,
,,	31 ..	20	10	0	,, ,,
April	1 ..	20	10	0	,, ,,
,,	2 ..	20	10	0	,, ,,

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	2 3 0	2 3 0	2 2 6	2 2 6	2 2 6	2 4 0	2 3 6	2 4 0	2 5 0	2 5 6	2 6 6	2 5 6	2 3 11½
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12 6	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 3 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 14 0	3 13 6½	4 1 6	
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	—	—	—	—	—	—	—	—	—	—

* No prices available during strike period.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

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